SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH, 1928.

GENERAL PHYSICS.

507. Laboratory Clock with Photoelectric Signal Control, with an Application to Timing a Pendulum by the Method of Coincidences. J. E. Fox, P. Rood and W. G. Marburger. *J.O.S.A. and R.S.I.* **15.** ***pp.*** **364–369,** ***Dec.,*** **1927.**

A slit in the pendulum of the standard clock allows light to fall upon a potassium photoelectric cell when the pendulum passes through its position of rest. The current was amplified by means of a tube amplifier and audible signals obtained with a telegraph sounder. A similar arrangement was used with a pendulum, which was to be timed in terms of the standard clock, and coincidence was signalled by a flash of a small signal lamp. Very accurate results can be obtained in this way. H. N. A.

508. Improved Apparatus for the Removal of Dissolved Gases from Water. J. R. Lorah, K. T. Williams and T. G. Thompson. *Am. Chem. Soc., J.* **49.** ***pp.*** **2991–2994,** ***Dec.,*** **1927.**

Apparatus for the removal of dissolved gases consist in general of three types: vacuum, and heat only, and vacuum and heat in combination. The present apparatus combines the good features of the van Slyke vacuum type with that of the Treadwell-Hall heat type. It is adaptable to any size of system or amount of gas, provides means of making a sharp separation of water from gas, employs the minimum number of joints consistent with ease of manipulation and also provides a seal for each joint. H. H. Ho.

509. Aircraft Instruments. E. Huguenard, A. Magnan and A. Planiol. *Comptes Rendus,* **185.** ***pp.*** **1016–1018,** ***Nov.*** **14, 1927.**

Describes a new form of densigraph and barograph and an air-speed indicator compensated for the pressure and temperature of the air. The method of compensation employed is described in the paper. J. W. T. W.

510. Testing Machine for Glass Tubing and Rod. R. F. Proctor. *Journ. Sci. Instruments,* **4.** ***pp.*** **465–470,** ***Dec.,*** **1927.**

An apparatus is described for testing the strength of glass tubing or rod of ordinary dimensions. The maximum strain in the tube at the moment of fracture is used as a criterion of the strength of the glass. A bending moment is applied to the two ends of the specimen, and the breaking strain is derived from a determination of the radius of curvature immediately before fracture. Some results of tests on glass tubes of various diameters are given, and a comparison of tests on annealed and unannealed tubing. AUTHOR.

511. Surface Tension of Liquid Carbon Dioxide. E. L. Quinn. *Am. Chem. Soc., J.* 49. *pp.* 2704–2711, *Nov.*, 1927.

The author was led to inquire whether liquids existing only under very high pressures behave in the same manner towards solutes as those with which we are most familiar. It is pointed out that one of the most useful properties of a liquid which can be used for calculating its internal pressure, and therefore its position in a solubility table, is its surface tension. Liquid carbon dioxide being a suitable liquid for the problem in mind, careful measurements of its surface tension were made, the solubility relations of this compound are predicted, and it is hoped that the results obtained will be checked against some actual solubility determinations. An equation is derived for calculating the density of the saturated vapour of carbon dioxide from 25° to 0° C., agreeing well with the observed densities over this range, and use of this equation is made to calculate densities down to — 52·2° C. It is deduced that carbon dioxide has an internal pressure about the same as carbon tetrachloride, toluene and chloroform. J. K.

512. Micro Method for the Determination of Surface Tension and Density. V. R. Damerell. *Am. Chem. Soc., J.* 49. *pp.* 2988–2991, *Dec.*, 1927.

Although several micro methods for the determination of surface tension and density are known [see, for instance, Abstract 1978 (1924)], none of the apparatus employed is applicable to both determinations. The present method remedies this defect and possesses the advantage of requiring not more than one-tenth of a c.c. of sample for both determinations, which are performed with the same apparatus to an accuracy of from 1 part in 100 to 1 in 300, depending on the liquid. Results are given for water, benzene, carbon tetrachloride, ether, toluene, nitrobenzene, aniline and dimethylaniline. H. H. Ho.

513. Adhesion of Mercury in Closed Capillary Tubes. A New Manometer. C. Hagen. *Phys. Zeits.* 28. *pp.* 735–737, *Nov.* 1, 1927. *Zeits. f. tech. Phys.* 8. 12. *pp.* 599–603, *Dec.*, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

Gives additional details of the phenomenon described by the author in a previous paper [see Abstract 1501 (1926)]. In the new manometer two glass bulbs are used below the vertical closed capillary tube, a small one A above, and a much larger one B below; between A and B is a side tube leading to the vacuum space, which can be closed by means of a valve operated electrically. When the valve is open, the gas in B escapes when the movable mercury reservoir is raised, while that in A is trapped and can be driven up into the capillary tube. When the reservoir is again lowered, the mercury will hang in the capillary if the original pressure is fairly low, and a relation can be found between the length of the suspended column and the pressure. The latter can be measured with the side tube closed, using the apparatus as a McLeod gauge. For very low pressures, with the side tube closed, the whole of the gas in A and B can be driven up into the capillary tube, and from the length of suspended column measured the pressure can be calculated, using the data obtained in the first experiments. H. N. A.

514. Adhesives and Adhesion: Gums, Resins and Waxes between Polished Metal Surfaces. J. W. McBain and W. B. Lee. *J. Phys. Chem.* **31.** *pp.* **1674–1680,** *Nov.*, **1927.**

Previous papers on adhesion are referred to [see Abstract 1196 (1926)] and it is shown that the thinner the layer of adhesive the stronger is the joint and that the effect of thickness is not appreciable with very thick films, but this effect rapidly increases when the thinnest possible films are studied. Data is also given concerning the strength of joints between metals in relation to such adhesives as waxes, shellacs, gums and resins, this, it is pointed out, being of increasing importance owing to the development of the lacquer industry. It is also shown that on the whole a parallelism exists between the strength of a joint between smooth metallic surfaces and the mechanical and intrinsic properties, such as internal pressure, tensile strength, elasticity, hardness and conversely compressibility and atomic volume, of the metals themselves. J. K.

515. Periodic Anomalies in the Properties of Long Chain Compounds. W. B. Lee. *Faraday Soc., Trans.* 23. *pp.* 630–640, *Nov.*, 1927.

From a consideration of a large number of properties, such as static friction, adhesion, cohesion, surface tension, surface pressure and the electrical properties of monomolecular films on water, viscosity dissociation constants, optical activity, magnetic rotation, toxicity, etc., cumulative evidence is adduced indicating that a well-defined irregularity or turning point exists in the properties of certain long chain compounds which usually first becomes evident at the fifteenth carbon atom in the chain, although less pronounced irregularities may be found earlier. The anomalous properties are explained by such a disposition of the carbon atoms in space as may cause a periodicity in those properties of the molecule which are ultimately dependent upon residual affinity. It would seem that polarity is a factor to be taken into account in connection with molecular rotatory power, and, whilst the evidence is not in accord with the models of the carbon chain deduced by X-ray analysis, the existence of an open pentagonal type of structure might occur if certain carbon atoms and linkages possessed free rotation. On this hypothesis the increments in molecular volume for each CH_2 group added to the chain might be expected to become non-alternating with respect to the odd and even members of a series at temperatures above the melting point. The available evidence tends to confirm the latter viewpoint. H. H. Ho.

516. Simplified Calculation of Elastic Solids Decomposable into Prismatic Segments. O. Sesini. *Accad. Sci. Torino, Atti,* **72. 13*a*–14*a*.** *pp.* **202–206, 1926–1927.**

Among the procedures employed in technical mechanics for treating plane elastic systems decomposable into accurately or approximately prismatic segments, graphic methods based on the theory of the ellipse of elasticity furnish a simple means of allowing for deformations due to axial strain and to section. With analytical methods the calculation of these deformations becomes more complicated, but where it is necessary to consider the deformations due to flexion and axial strain, leaving out of account those due to section, these methods may be much simplified without loss of accuracy. The treatment of the problems involved is entirely mathematical. E. F.

517. Photoelasticity. Z. Tuzi. *Inst. Phys. and Chem. Research, Tokyo, Sci. Papers, Nos.* 112–114. *pp.* 79–129, *Oct.* 18, 1927.

The present investigation is published in three papers entitled "A New Material for the Study of Photoelasticity" (pp. 79–96), "Photoelastic Study of Stress on a Specimen of Three-Dimensional Form" (pp. 97–103) and "Photoelastic Study of Stress in a Heat-Treated Column" (pp. 104–129). In the first two papers the author has described how a new material, "Phenolite" (made from phenol and formaline by the catalytic action of ammonia at ordinary pressure), is found to be exceedingly suitable for specimens in the study of photoelasticity, whilst it possesses a large thermal expansion and small conductivity. The third paper describes an attempt made by the photoelastic method to study the internal stress of a column which is cooled suddenly from a high temperature. The conclusion drawn with respect to the mechanism of sudden cooling is that in a rectangular section, for example, the outside layer is hardened at first somewhat too large, because the inner portion is still hot and occupies a large volume due to its large coefficient of expansion. Afterwards the inner portion is also cooled and consequently contracts, drawing in the outer layer. The experimental values in the study of stresses, resulting from higher tension at the centre of the section and something of compression at the middle points of the sides, seem to coincide with the above conclusion, as does also the deformation of the column surfaces. Appendices describe the experimental determination of the thermal expansion and thermal conductivity of phenolite. H. H. Ho.

518. A Radiation Method of Measuring Strain in Glass. C. E. Mendenhall, L. R. Ingersoll and N. H. Johnson. *J.O.S.A. and R.S.I.* 15. *pp.* 285–289, *Nov.*, 1927.

A method, using infra-red radiations, founded upon Brewster's optical polarisation method. A suitable thermopile-galvanometer arrangement is used in conjunction with Nicol prisms. A. D.

519. Determination of the Deformations of an Elastic Membrane under given External Forces. F. Löbell. *Zeits. Math. u. Mechanik,* 7. *pp.* 463–469, *Dec.*, 1927.

The present mathematical paper treats the problem of the elastic deformation of non-planar membranes by an alternative method to that employed by Lagally [see Abstract 749 (1925)], who referred all possible states of tension to the same differential equation from which Weingarten derived a solution for the infinitesimal straining of a surface. The determination of the deformation of a membrane from considerations based on Hooke's law has resulted in a differential equation which only differs slightly from that of Weingarten. In the first part of the paper the deformations of a surface are expressed by a linear, in general non-homogeneous, partial differential equation which appears in vectorial form. In the second part it is shown that all states of tension in a membrane, which are in equilibrium with a given system of external forces, may be derived from the general solution of a vector differential equation which only differs from that in the first part by another disturbance term. The introduction of components of the vector function, which satisfy the above equation in three particular directions, leads finally to the generalised Weingarten differential equation. H. H. Ho.

520. Method for Determining the Tensile Strength of Gelatine Jellies. A. Rosinger and J. J. Vetter. *Am. Chem. Soc., J.* 49. *pp.* 2994–3003, *Dec.*, 1927.

The apparatus and method now described for the study of the elastic properties of gelatine jellies depends on the static loading of jelly membranes and is based on the fact that a circular elastic membrane supported rigidly at its circumference and subjected to air pressure on one side assumes a spherical form. The apparatus can be used to study the time of relaxation of stretched membranes, and the method is applicable to the study of any elastic medium that can be formed into a membrane. The influence of chrome alum and formaldehyde on gelatine jellies is shown. H. H. Ho.

521. The Moment of Inertia of a Quadrangle. Rehfeld. *Phys. Zeits.* 28. *pp.* 762–766, *Nov.* 15, 1927.

In this paper it is shown how the principle of geometrical relationship can be employed with advantage for the determination of the moments of inertia of geometrical structures by consideration of a subdivision into several mutually congruent portions. The case of a quadrangle is shown to depend on the suitable configuration of nine points. H. H. Ho.

522. Large Angular Velocities derived from Motors without Solid Axle. E. Henriot and E. Huguenard. *J. de Physique et le Radum*, 8. *pp.* 433–443, *Nov.*, 1927.

The construction of small motors, supported on a thin skin of gas, utilising the Bernoulli effect, and rotated by gas, and capable of attaining speeds up to 11,000 revs. per sec. is described. The stability of the rotation is attributed to a hyper-turbulent condition of the gas skin rendering it rigid. The device has been applied in connection with the revolving-mirror method of determining the velocity of light over a distance less than 1 metre. J. S. G. T.

523. Gelation of Silicic Acid. The Formation of Gas Bubbles and Drops in Silicic Acid during Gelation. H. A. Fells and J. B. Firth. *Faraday Soc., Trans.* 23. *pp.* 623–630, *Nov.*, 1927.

This paper continues previous work [see Abstract 39 (1927)], and in the series of experiments described a continuous record of the several stages of gelation has been obtained by means of a study of the behaviour of internal gas bubbles. After gelation, up to the condition for the formation of the extremely thin film-like bubble which brought about a permanent fracture in the gel, the only apparent change in the gel was that of continued increase in rigidity. It was only subsequent to this stage that external syneresis was observed. It would appear that the silica gel is always tending to the ultimate formation of crystalline anhydrous silica and that the change is accompanied by considerable shrinkage and corresponding expulsion of the free water. It is this tendency of the hydrated silica particles to orientate themselves towards

the final production of a crystal lattice, with consequent loss of water, which is responsible for the formation of capillaries in the hard gel.
H. H. Ho.

524. Bubbles and Drops and Stokes' Law. W. N. Bond. *Phil. Mag.* 4. *pp.* 889–898, *Nov.*, 1927.

This paper extends Stokes' calculations for the slow rectilinear motion of a solid sphere through a viscous fluid to the case where the sphere is composed of fluid. Experiments on the rate of rise of air bubbles in water-glass and in golden syrup, and on the velocity of the fluid in the neighbourhood of the bubbles in the former liquid, are in substantial agreement with the prediction that the bubble should rise 1½ times as fast as it would if it were solid. Observations on air bubbles and drops of syrup in castor oil also show reasonable agreement with theory. The measured velocities of the fluid near steel spheres give a reasonably good check on Ladenburg's correction for the effect of the walls of the containing vessel. An addendum gives a correction for circulation of liquid inside the drop.
H. H. Ho.

525. Velocity of Ascent of Air Bubbles in Water. F. M. Exner. *Phys. Zeits.* 28. *pp.* 825–829, *Dec.* 1, 1927.

Measurements here given show that the velocity of ascent of air bubbles in water depend scarcely at all on their depth, and that for any particular size of bubble it is moderately constant. The velocity, however, increases with the size of the bubble. Up to the present it has generally been considered that a complete solution of the question " how quickly a body moves in a fluid " could only be obtained experimentally. In the present paper a simple solution is given depending on the energy equation of motion.
A. E. G.

526. Non-Uniform Rotation of an Endless Cylinder in a Viscous Infinite Fluid. C. Ferrari. *Accad. Sci. Torino, Atti,* 72. 13*a*–14*a*. *pp.* 209–216, 1926–1927.

Let a cylinder of infinite length and radius R, initially at rest, rotate on its axis with an angular velocity defined by a known function $f(t)$ of the time. It is proposed to determine the field of velocity excited in the fluid by such rotation, assuming in the first instance perfect adhesion between the surface of the body and the fluid, and subsequently modifying the solution of the problem so as to allow for possible slip. With this object the author integrates the general equations of plane viscous motion and seeks for a particular integral capable of satisfying boundary conditions. Supposing that, starting from a given moment $t = a$, the peripheral velocity of the cylinder remains constant $= k$, he obtains for $t = \infty$ the known hyperbolic law of variation of the velocity with the distance r from the axis $v = kR/r$, corresponding to the field of velocity of an infinite rectilinear vortex. The formulæ found enable the further study to be made of the variation of vorticity with the time, which for $t = \infty$ is nil.
E. F.

527. Hydrodynamics of Systems of Variable Viscosity. M. Reiner and R. Riwlin. *Kolloid Zeits.* 43. *pp.* 72–78, *Oct.*, 1927.

The mechanics of the forces operating in the Couette rotating cylinder viscometer are discussed. The large influence of rate of shear on the viscosity of a sol is attributed to the solvent shell around each colloid particle being sheared away in proportion to the velocity gradient so that the larger the solvent shell the greater is the influence of velocity gradient on the viscosity. Beginning with the Hatschek-Einstein equation $\eta = \eta'(1 + \alpha f)$, where η is the viscosity coefficient of a colloidal solution, η' that of the dispersion medium, f the ratio between the virtual volume (true volume + volume of shell) of the disperse phase to that of the total volume and α a constant, the following relation is derived for the influence of rate of shear on the apparent volume of the disperse phase: $f = (f_0 - f_\infty)e^{-C_1 G} + f_\infty$, where f_0 is the relative virtual volume of the disperse phase when at rest, and f_∞ the value at a very rapid rate of shear, G is the velocity gradient and C_1 a constant for the sol. An equation derived for the resistance coefficient of Freundlich, ω, or a viscosity value which is independent of the apparatus is as follows:—

$$\omega = (\eta_0 - \eta_\infty)e^{-C_1\frac{R_B^2 + R_A^2}{R_B^2 - R_A^2}\Omega} + \eta_\infty,$$

where η_0 is the viscosity coefficient of the stationary sol, η_∞ the viscosity coefficient at very high rate of shear, R_A the radius of the inner cylinder and R_B that of the outer cylinder and Ω the rotation velocity of the outer cylinder.

(*Ibid.* 44. *pp.* 9–10, *Jan.*, 1928.)

A relation derived to express the influence of rate of shear on viscosity when measured by the capillary viscometer is given by the equation

$$\omega = (\eta_0 - \eta_\infty)e^{-\frac{1}{2}C_1 Rp/\eta_0 l} + \eta_\infty,$$

where R is the inner radius of the capillary, l its length, and p the driving pressure. J. N. P.

528. Effect of Temperature on the Viscosity of Air. R. S. Edwards and A. O. Rankine. *Roy. Soc., Proc.* 117. *pp.* 245–257, *Dec.* 1, 1927.

In this investigation the ratios of the viscosities of air at various temperatures between 15° C. and 444·5° C. have been determined, using a constant volume method and vapour jackets to obtain definite temperatures. The results have been compared with the work of previous observers [see Abstract 1193 (1926)], and Sutherland's formula for the variation of viscosity with temperature shown to be strictly obeyed over the range considered. A value of 118 has been obtained for his constant.

H. H. Ho.

529. Cellular Vortices and Rayleigh's Theory. H. Bénard. *Comptes Rendus*, 185. *pp.* 1109–1111, *Nov.* 21, 1927.

A thin layer of liquid, heated from below, forms by convection currents a set of cellular vortices. Lord Rayleigh calculated that for square cells the side should, for stability, be 2·83 times the thickness of the layer, and for hexagonal cells 3·29 times. These values agree well with experimental results. W. G. B.

530. Theory of Porous Flow. E. E. Libman. *Phil. Mag.* 4. *pp.* 1285–1290, *Dec.*, 1927.

The theory is worked out mathematically, on lines similar to those used for electrostatic or magnetic flux. The flow in a porous material depends on the effect of capillarity, on pressure gradient caused by shrinkage and on gravity. Defines a function ϕ, the flow function, which regarded as a function of the moisture density only is a property of the material, and is such that when the Z axis is vertical the masses of fluid flowing in unit time through unit area normal to each of the axes are $f_x = \frac{\partial\phi}{\partial x}$, $f_y = \frac{\partial\phi}{\partial y}$, $f_z = \frac{\partial\phi}{\partial z} - kg\tau$. A method of determining ϕ experimentally is described. H. N. A.

531. Disturbing Forces in the Motion of a Solid in a Liquid, near a Boundary Wall. B. Demtchenko. *Comptes Rendus*, 185. *pp.* 1186–1189, *Nov.* 28, 1927.

When a body moves in a fluid, near a fixed boundary wall, this alters the apparent inertia and the Joukowski force. These effects are calculated as integrals involving the change in velocity distributions due to the wall. W. G. B.

532. Dipole Moment and Anisotropy of Fluids. L. Ebert and H. v. Hartel. *Phys. Zeits.* 28. *pp.* 786–790, *Nov.* 15, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

The authors have measured the molecular polarisations of three different organic substances which give anisotropic melts, and from these in each case have deduced an upper limit for the polarisation of orientation. The substances were dissolved in benzol, the solutions being dilute. The molecular polarisations were calculated from the measured dielectric constants by means of Debye's formula. The polarisation of orientation was also calculated from Born's theory of mesophases, and the minimum possible value that could fit this theory arrived at. This value, however, in all three cases was much larger than the corresponding maximum value calculated from the authors' measurements, so that it is not possible to account for the properties of these mesophases by means of Born's theory of dipoles. Other arguments point in the same direction, and the authors consider that the theory of Oseen, who only assumes that the potential energy of two molecules depends on their relative orientation, is much more promising. This would include the cases in which the molecules of mesophases have an elongated form. H. N. A.

533. Structure of Tetramethylammonium Halides. L. Vegard and K. Sollesnes. *Phil. Mag.* 4. *pp.* 985–1001, *Nov.*, 1927.

An X-ray study by means of the photographic powder method of the *isomorphous* compounds Cl-, Br- and $I(CH_3)_4N$. The cell sizes are given in the following table:—

	a Å.	*c* Å.	*c*/*a*.
$N(CH_3)_4I$	7·91	5·74	0·7256
$N(CH_3)_4Br$	7·708	5·501	0·7137
$N(CH_3)_4Cl$	7·588	5·374	0·7082

The space group is D_4^7h.

From consideration of the intensities of the spectral lines, positions are suggested for the C, N and halogen atoms. Consideration of the arrangement of the hydrogen atoms suggests a diameter of 1·70 Å. When the results are compared with those of the related ammonium halides it is found that the side of the cube of one molecule for the mother substance is approximately equal to the height of the prism containing one molecule of the substitution product. W. H. Ge.

534. The Metallic State. W. Hume-Rothery. *Phil. Mag.* 4. *pp.* 1017–1045, *Nov.*, 1927. *Supplement.*

Discusses the different theories of the metallic state, and shows that the electron lattice theory of Lindemann is capable of explaining the facts when it is remembered that the minute electrons may be regarded as occupying the spaces between the metallic ions and that the attractive forces they exert on them are inclined to the repulsive forces between neighbouring positive ions. The process of closing together is stopped, not as in most salts by the " contact " of ions of opposite signs, but by the " contact " of the positive metallic ions. It is shown that as a result of this difference the distance of closest approach of the ions in the alkali metals differs from the diameter of the same metallic ion in halide crystals, and that, with the exception of cæsium, there is a practically constant ratio between these two lengths. The compressibility data of Bridgman agree with this fact. The theory is worked out in detail for crystals with different lattice structures, and is shown to account for a number of experimental facts with regard to their deformation. Supraconductivity at the temperatures of liquid helium is also dealt with, as well as metallic conductivity at ordinary temperatures. H. N. A.

535. Crystallography of Some Simple Benzene Derivatives. W. A. Caspari. *Phil. Mag.* 4. *pp.* 1276–1290, *Dec.*, 1927.

The substances dealt with contain one benzene ring, with no other substituent groups than $-$OH and $-$NH$_2$. The three dihydroxy-benzenes have been previously examined by X-rays, and the author gives the data of seven other of these compounds, which he has examined mainly by the rotating crystal method, determining the cell dimensions, number of molecules in the cell and the space group for each case. The results for all these substances have been tabulated, and attention is called to the fact that one cell dimension is about 5·5 Å. in all three of the dihydroxy-benzenes. This side of the cell appears to be fully occupied by the spatial extent of one molecule; this spacing appears to agree with the breadth of the hexagonal benzene ring. The cell dimension 5·5 Å. and its integral multiples, as also $5{\cdot}5 \times 1{\cdot}5 = 8{\cdot}34$ Å., appear again and again in the table. This can hardly be merely accidental. It is suggested that the last number represents the length of the molecule. H. N. A.

536. Loosening of the Crystal Lattice. G. v. Hevesy and G. Rienäcker. *Ann. d. Physik*, 84. 5. *pp.* 674–688, *Nov.* 19, 1927.

To illustrate the manner in which the bonds of a crystal lattice can be loosened by heating α-silver iodide and α-copper iodide have been studied. It was found that when pastilles of these two solids were pressed together and heated to 480° C., they diffused into one another, and practically complete mixture took place quite rapidly, nearly as quickly as with the melted salts. The velocity agreed with that calculated from the electrolytic conductivities of the two substances. This is regarded as a con-

clusive proof of the fact that in compounds which are good conductors electrolytic conduction does not depend on a surface flow along the surfaces of submicroscopical pores, but on a reversible thermal loosening of the crystal lattice. For bad conductors the reverse appears to be true.
H. N. A.

537. Preparation of Large Single Crystals. H. C. Ramsperger and E. H. Melvin. *J.O.S.A. and R.S.I.* 15. *pp.* 359–363, *Dec.*, 1927.

Describes a heating and crystallising apparatus with electric heaters above and below and an automatic device for controlling the temperature. Cooling takes place very slowly from the bottom, where the crystal starts its growth, and the temperature gradient should be uniform from top to bottom. Crucibles can be made of very thin pure platinum foil, which is soft and malleable, which shrinks with the crystal and only strains it slightly. Crystals of lithium fluoride, sodium chloride, sodium nitrate and mercuric bromide have been prepared; those of the last three split up on cooling, as thick platinum crucibles were employed. The lithium fluoride crystal, which was obtained in a thin platinum dish, filled the whole dish and was about 1·75 in. in diameter and 1·5 in. high. It is hoped that crystals prepared in this way will prove suitable for optical purposes.
H. N. A.

538. Röntgenographic and Electrical Investigation of the System Palladium-Hydrogen. J. O. Linde and G. Borelius. *Ann. d. Physik,* 84. 6. *pp.* 747–774, *Dec.* 3, 1927.

Measurements, by means of a Debye camera of special construction, of the lattice constants of palladium in an atmosphere of hydrogen at pressures between 0·1 and 4 atmospheres and at temperatures between 100° and 200° indicate the existence of two phases, one with lattice constants between 3·888 Å. (pure palladium) and 3·92, and the other above 3·97. The phase poorer in hydrogen [see Abstract 2628 (1927)] is to be regarded as hydrogen dissolved in palladium, and the one richer in hydrogen as pure or supersaturated Pd_2H, which has the lattice constant 3·978. It appears probable that two different forms of Pd_2H exist. Under suitable conditions a third phase is formed, an apparently steady progression occurring in the hydrogen solution beyond the concentration of Pd_2H. With electrolytic charging, using various current densities, times and temperatures (20° and 90°), the determination of the lattice constants by the X-ray focussing method shows that here also a hydrogen-rich phase is formed by way of a two-phase intermediate state. This phase has a higher lattice constant (4·034 at 20°, 4·023 at 90°) than that obtained by absorption of gas, and may be further supersaturated to a lattice constant of over 4·07. An approximately linear relationship exists between the concentration of the hydrogen and the lattice constant. The preparation of resistance-temperature diagrams is of value in the study of the formation and dissolution of the different phases. For concentrations above about $c = 0{\cdot}85$ H/Pd the resistance diminishes rapidly, a comparatively low resistance corresponding with the composition PdH. The pressure-concentration diagram is discussed on the assumption that the system palladium-hydrogen is to be considered as a metallic mixed crystal system with the components Pd, and PdH, in which, as in the systems Cu-Au, Cu-Pd, and Cu-Pt investigated by Johannson and Linde [see Abstract 1636 (1927)], both regular and irregular distribution of the components on the lattice points should be possible. A resistance-concentration diagram framed on the present and also earlier measurements is in accord with such assumption. T. H. P.

539. Tensile Tests on Alloy Crystals. Part IV. A Copper Alloy containing 5 % Aluminium. C. F. Elam. *Roy. Soc., Proc.* 116. *pp.* 694–702, *Nov.* 1, 1927.

The alloy contained 5 % of aluminium, and crystals were easier to prepare than the brass crystals previously investigated [see Abstract 2454 (1927)]. It was found on etching that the crystals were not always of uniform orientation throughout and were much cored. The general behaviour of the crystals was in general similar to that of copper-zinc alloys and showed the effect of non-homogeneity on distortion. When the crystal is deformed the coring disappears, the slip planes which cut across the cores break them up, and the material is actually transferred along the direction of slip, so that the composition becomes more uniform. The copper-aluminium alloy at the beginning of a test is harder than copper, while a copper-zinc alloy is softer. Copper hardens more rapidly than either of the alloys, and the alloying elements facilitate slip; very large extensions are obtained with the alloys. Attention is called to the difference of behaviour between these alloys and those of aluminium and zinc. H. N. A.

540. Investigations of the Molecular Arrangement of Uniaxial Optically Active Crystals. W. G. Burgers. *Roy. Soc., Proc.* 116. *pp.* 553–586, *Nov.* 1, 1927.

Considers the lamellar theory, which has been propounded for explaining the properties of optically active crystals. There seems to be little doubt that in some cases this theory is correct, but the uniaxial optically active crystals so far investigated by X-rays are not built up of relatively large laminæ, with the possible exception of potassium lithium sulphate. A number of other theoretical points are dealt with, and the author proceeds to an X-ray investigation of *d*-potassium rhodium oxalate, sodium metaperiodate, ethylene-diamine sulphate and guanidine carbonate; it is concluded that there is no spiral arrangement of biaxial lamellæ, but that there is some special arrangement of atoms within a unit of structure in each case. This unit is a real unit if the crystal is truly uniaxial, but is a pseudo-unit if the crystal is built up of very many twinned lamellæ individually too small to give X-ray reflections; the pseudo-unit corresponds to a real elementary cell of the lamellæ or to a sub-multiple of one. The space groups or " pseudo " space groups of the units have been determined, and the spiral arrangements within them discussed. Other points are dealt with in the original paper. H. N. A.

541. Theory of Atomic Structure and Spectral Series. L. Décombe. *Comptes Rendus,* 185. *pp.* 1263–1265, *Dec.* 5, 1927.

Develops the theory previously put forward, which regards the protons as spherical electrified films vibrating radially. The radial vibrations of the electrons probably do not have much to do with gravitation, but appear to be of fundamental importance spectroscopically. On certain assumptions deduces formulæ for the frequency of this vibration in an electron the velocity of translation of which is zero, and for one with velocity *v*. The differences between the frequencies at different velocities are not large, and beats may result when two electrons have different velocities. The frequency of these beats, when the electrons are revolving in suitable circular Bohr orbits, follows Rydberg's formula. The frequency of the radial vibrations when $v = 0$ is calculated as $1 \cdot 2 \times 10^{20}$; for an electron with velocity v this frequency is $1 \cdot 2 \times 10^{20} + \mu_0 v^2/2h$, where μ_0 is the mass of an electron with velocity zero and h is Planck's constant. The theory also explains the production of the continuous background of the X-ray spectrum, limited on the high-frequency side, when a metal is bombarded by electrons with velocity v, and also the production of the characteristic spectrum with the lines of the same series appearing simultaneously. H. N. A.

542. Structure of the Atom and Radiation. J. J. Thomson. *Brit. J. of Radiology*, **23.** *pp.* **254–264**; *Disc.*, **264–265**, *Oct.*, **1927**. *Silvanus Thompson Memorial Lecture.*

Describes a theory of atomic structure which assumes that the force between a proton and an electron at atomic distances alternates between attraction and repulsion as the distance varies, so that there is a certain number of positions of stable with intervening positions of unstable equilibrium. This might be due to a proton much larger than that usually assumed, with a periodic structure of alternately positive and negative charges, the algebraic sum of which is $+ e$. The electron rotates like a top, and it is supposed that rotation is inherent in the electric field and that the atom of H has a moment of momentum about the line joining the centres of the proton and the electron, which is in a position of equilibrium. If the electron receives an impulse the atom will precess, the line joining the centres describing a cone with its apex at the centre of the proton. It is shown that the frequency of this rotation and that of the radiations given out by the electron is He/m, where H is the quasi-magnetic force acting on it. The quasi-magnetic force varies periodically with the distance from the centre of the atom. The electrons in any atom are in definite positions on the surfaces of stable equilibrium, the number on any one of these shells being limited owing to the mutual repulsion between them. The atom thus has a kind of crystalline structure. When an electron falls from one shell to another it gains energy of revolution about the radius, and this is radiated at the frequency mentioned above. The theory is tentative, but the lecturer thinks that, owing to its being largely statical, it may for some purposes prove more useful than the Bohr theory. H. N. A.

543. Some Properties of Atomic Hydrogen. J. Kaplan. *Phys. Rev.* **30.** *pp.* **639–643**, *Nov.*, **1927**.

Duration of atomic hydrogen in a bulb 20 cm. in diameter.—A large bulb of 3 litres capacity was sealed to the middle of a Wood's hydrogen tube and the atomic hydrogen formed in the discharge tube was allowed to enter the bulb. It was found that atomic hydrogen could be detected, by means of a speck of Welsbach mantle, three seconds after the discharge was shut off. The piece of Welsbach was quite large, which indicated that there was still probably considerable atomic hydrogen in the bulb even after three seconds. Certain other effects, such as small white infected spots on the glass, which were due to atomic hydrogen, were observed for as long as six seconds after the discharge was discontinued. There were indications that the atomic hydrogen lasted as long as ten seconds, but, because of impurities in the tube, these indications may have been due to something else. It has also been shown that, in the absence of water, a surface is a much better catalyser than when water is adsorbed on it. Several curious phenomena are described. AUTHOR.

544. Scattering of Radiation from Atoms. I. Waller. *Phil. Mag.* 4. *pp.* 1228–1237, *Nov.*, 1927. *Supplement.*

The Kramers-Heisenberg dispersion formula gives the radiation scattered from an atom for wave-lengths long compared with atomic dimensions. This formula has been deduced from the principles of wave-mechanics by Schrödinger and Klein. Following a procedure analogous to that of Klein, the author deduces in § 1 of the present paper a dispersion formula which also gives the radiation scattered from an atom for wave-lengths short compared with atomic dimensions. In § 2 this formula is used to find the gradual transformation of the scattering process as the wave-length varies. For long waves the dispersion is given by the Kramers-Heisenberg formula, and for sufficiently short waves there is a pure Compton effect. In § 1 the approximation to the eigen functions of the continuous spectrum given by plane de Broglie waves is discussed, and also the expansion of the wave-functions of the stationary states in Fourier integrals. The corrections due to the spin of the electrons are neglected in the paper. AUTHOR.

545. Theory of the Impact of Atoms with Slow Electrons. Lucy Mensing. *ZS. f. Phys.* 45. 9–10. *pp.* 603–609, 1927.

The impact problem of slow electrons is worked out for the atomic model of a charged spherical shell strictly in accordance with wave mechanics. The result differs essentially from that of the corresponding optical problem of the diffraction of light waves by small particles. The effective cross-section does not proceed as in the optical problem with $1/\lambda^4 \sim v^4$ (v = electron velocity) to zero, but assumes for slow electrons a definite boundary value. This is closely dependent on the spherical radius and the nucleus charge and, with suitable radii, lies far below the atomic section. Quantitative statements for the various gases of the helium group cannot be made, the shell model proving insufficiently delicate for the purpose. [See also Abstract 43 (1927).] E. F.

546. Atomic Structure and the Magnetic Properties of Coordination Compounds. L. C. Jackson. *Phil. Mag.* 4. *pp.* 1070–1080, *Nov.*, 1927. *Supplement.*

Continues the discussion of the magnetic properties of coordination compounds, with reference to the schemes of Welo and Baudisch, of Bose and of Cabrera, taking up compounds with anomalous properties, such as iron and nickel carbonyls, ferric acetylacetonate, the complex nickel cyanides $Na_2Ni(CN)_4$ and $K_2Ni(CN)_4$, and a number of binuclear and trinuclear compounds. Cabrera's scheme is better able to account for the general facts than either of the other two. A possible experimental test of the theories by means of X-rays is suggested. H. N. A.

547. The Action of Magnetic, Electric and Mechanical Forces on Mesophases. H. Zocher. *Phys. Zeits.* 28. *pp.* 790–796, *Nov.* 15, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

Those states in which some of the six operations by which changes take place (three translations and three rotations) are periodic, but the others are statistically continuous, are distinguished from the crystalline and amorphous states, including ordinary fluids, and known as mesophases, or intermediate states. This definition is compared with some opinions on the subject which are frequently held. The author discusses the manner in which movable systems place themselves in a magnetic field, and shows that it is impossible to obtain an electrical polarisation by the action of a magnetic field on systems which are not enantiomorphous. Anisotropy produced by an electrical field is shown to be connected with chemical constitution, both theoretically and experimentally. The effect of the action of the boundaries is considered. The possible mechanical peculiarities of mesophases are deduced and are in part treated mathematically and experimentally. H. N. A.

548. Hydrodynamic Interpretation of the Quantum Theory. A. Carrelli. *Accad. Lincei, Atti*, 5. *pp.* 990–995, *June* 19, 1927.

Extends Madelung's "Einelektronproblem" [Abstract 1286 (1927)] to the problem of three degrees of freedom with the sole limitation that the variables are separable, and shows that the equations obtained are those of a fluid endowed with vortex motion. E. E. F. d'A.

549. Quantum Theory of Molecules. M. Born and R. Oppenheimer. *Ann. d. Physik*, 84. 4. *pp.* 457–484, *Nov.* 2, 1927.

The wave equation of quantum mechanics for the problem of an assembly of nuclei and electrons takes the form $(H_0 + \mathcal{H}^4 H_1 - W)\psi = 0$, where $H_0 = T_E + U$, $H_1 = T_K$, and $\mathcal{H} = \sqrt[4]{\frac{m}{M}}$. Here T_E and T_K are the operators corresponding to the kinetic energies of the electrons and the nuclei respectively, m and M are the electronic and average nuclear masses, and U is the potential energy of the whole system. The solution is obtained by perturbation theory from the case when $\mathcal{H} = 0$, which denotes a rigid system of nuclei. It is shown that the contributions to the spectral terms corresponding to the energies of electronic motions, nuclear oscillations and nuclear rotations are obtained as the terms of a power series in $\mathcal{H}$ of the zero, second and fourth orders respectively. Terms of the first and third order vanish, and those of higher order than the fourth involve coupling effects between the different types of motion. The eigen functions are derived and found to confirm the intensity relations in vibration bands laid down by Condon [see Abstract 2465 (1927)]. The general method is exemplified by reference to the particular case of diatomic molecules. W. S. S.

550. Progress in the Classification and Theory of Molecular Spectra. F. Hund. *Phys. Zeits.* 28. *pp.* 779–784, *Nov.* 15, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

This paper gives a review of the advances which have been made in systematising and explaining the spectra of molecules. (1) Systematic.—The first step was to investigate the multiplicity of the lines in band spectra, as analogous to the multiplets of atomic spectra. Similarity of the spectra of BO, CN, CO^+ and N_2^+ to the spectrum of the atom Na then led Mulliken to relate this similarity with the possession of a closed outer shell of eight electrons together with one valency electron, which determined the general character of the spectrum. Finally the laying down of exact rules for the fine structure was carried out on the basis of empirical material and with the aid of molecular models. (2) Quantum Mechanics of Molecular Spectra.—For the motion of the nuclei (rotation and vibration) the quantum mechanics lead to more satisfactory results than the older theory, notably in the justification of half-quantum numbers. For the motion of the electrons, the new theory deals successfully with the two-centre problem which presented an essential difficulty for the correspondence principle. References are given to the more important recent papers on the theory of molecular spectra. W. S. S.

551. Some Consequences of the Schrödinger Theory for Term Structures. E. Wigner. *ZS. f. Phys.* 45. 7–8. *pp.* 601–602, 1928.

Corrections to the original paper. [See Abstract 2663 (1927).]

552. Dynamical and Electrical Problems whose Solutions satisfy Schrödinger's Wave Equation. A. Bramley. *Frank. Inst., J.* 204. *pp.* 561–574, *Nov.*, 1927.

In this purely mathematical paper proofs are given of a number of relations between the periodic solutions of Schrödinger's wave equation and the solutions of certain problems in mechanics, in particular the Bohr-Sommerfeld quantum mechanics. W. S. S.

553. Structure of the Swan Bands. J. D. Shea. *Phys. Rev.* 30. *pp.* 825–843, *Dec.*, 1927.

A detailed quantum analysis of the Swan bands based on data obtained by Leinen, Komp, Hindrichs, and Johnson is given, including tables of the frequencies of the lines and their combination differences for the (0,0), (0,1), (1,0), (1,1) and (1,2) bands. Quantum numbers are assigned to all lines of the R and P branches of these bands, the Q branch not being observed. The moment of inertia of the Swan band carrier for infinitely small vibrations is found to be $15 \cdot 84 \,.\, 10^{-40}$ gm. cm.^{2} for the initial state in the emission process, and $17 \cdot 03 \,.\, 10^{-40}$ gm. cm.^{2} for the final state, with a probable error of less than $0 \cdot 1$ %. The constants of an assumed law of force of the form $F = k_1(r - r_0) + k_2(r - r_0)^2 + \ldots$ are evaluated. The multiplicity of the lines is investigated in detail, and it is shown in the case of the (0,0) band that the well-known "staggering" of alternate lines can be explained by the assumption of a double moment of inertia either in the initial or final state. The molecule $C^- - C^-$ is suggested as the probable carrier of the Swan bands, if such a doubly charged molecule can exist. W. S. S.

554. A Relativistic Theory of Quanta. D. J. Struik and N. Wiener. *J. Math. Phys., Mass. Inst. of Technology,* 7. *pp.* 1–23, *Sept.*, 1927.

A form of the theory of relativity embodying the theory of quanta as contained in Schrödinger's wave mechanics is developed. The theory is based upon Cotton's theory of the differential invariants of linear partial differential equations of the second order. It is shown that there is an intimate and direct connection between the Einstein field equations and the Fock-De Donder form of the Schrödinger wave equation in general relativity. The Kaluza-Fock-Klein five-dimensional quantum theory is shown to be equivalent to the present theory except that the former does not admit of a theory of normalisation. The application of the theory to the problems of two or more bodies is briefly discussed. J. S. G. T.

555. A Gauge-Invariant Tensor Calculus. M. H. A. Newman. *Roy. Soc., Proc.* 116. *pp.* 603–623, *Nov.* 1, 1927.

A differential calculus capable of dealing with tensors of various "weights" and ranks is developed. The equations preserve their form both under a change of coordinates and under a change of gauge-system. The general gauge-true equations resulting from the law $\delta \int R^2 \sqrt{g} = 0$ are obtained. The part independent of the "electrical" vector, ϕ_i, is found to be $G_{ik} - Gg_{ik}/4$, a tensor considered in Einstein's gravitational theory. J. S. G. T.

556. Remarkable Form of the Maxwell-Lorentz Equations in a Five-Dimensional Universe. G. Darrieus. *J. de Physique et le Radium*, 8. *pp.* 444–446, *Nov.*, 1927.

The Maxwell-Lorentz equations of the electromagnetic field in the Kaluza-Klein five-dimensional universe are deduced in the form

$$\pentagon \vec{P} = \Box \vec{P} + \partial^2 \vec{P}/(\partial x_0)^2 = 0,$$

$\vec{P}$ denoting the potential and x_0 the fifth dimension. J. S. G. T.

557. Repetition of the Michelson-Morley Experiment using Kennedy's Refinement. K. K. Illingworth. *Phys. Rev.* 30. *pp.* 692–696, *Nov.*, 1927.

The ether drift experiment as performed by Kennedy [see Abstract 908 (1927)] with a reduced optical system in helium has been repeated with the same apparatus somewhat modified and the same results obtained. The interferometer has been improved by resilvering the mirrors so that 1/1500 of a fringe shift could be detected by an observer with good eyes and 1/500 by an observer with poorer eyes. Additional readings, which eliminate steady thermal shifts of the fringes, have been made, and these show no ether drift to an accuracy of about 1 kilometre per second.

AUTHOR.

558. Absence of Ether Drift at the Rigi. A Piccard and E. Stahel. *Comptes Rendus*, 185. *pp.* 1198–1200, *Nov.* 28, 1927.

Results of experiments with a Michelson interferometer at the Rigi, under conditions approximating as nearly as possible to those of Miller, indicate no ether drift. [See also Abstract 1662 (1927).] J. S. G. T.

559. The Velocity of the Earth. E. Brylinski. *Comptes Rendus*, 185. *pp.* 1458–1459, *Dec.* 19, 1927.

The author considers that the results obtained by Piccard and Stahel using an interferometer at the Rigi tend to confirm rather than to contradict Miller's results. [See also Abstract 1663 (1927) and preceding Abstract.] J. S. G. T.

560. The Double Function of the Geodesic Movement in the Einstein Gravitation Theory. S. C. Kar. *Phys. Zeits.* 28. *pp.* 819–820, *Dec.* 1, 1927.

Reference is made to an earlier paper [see Abstract 153 (1928)]. The work of Teinsor is referred to. This paper is mathematical and does not lend itself to abstraction. J. K.

561. Determination of Geoidal Constants by Measurements of Gravity. C. Somigliana. *Accad. Sci. Torino, Atti,* 72. 8. *pp.* 117–124, 1926–1927.

A further mathematical examination of the problems treated in a previous paper. [See Abstract 1661 (1927).] E. F.

562. Determination of Terrestrial Flattening by Values of Gravity. G. Cassinis. *Accad. Sci. Torino, Atti,* 72. 15*a*. *pp.* 245–248, 1926–1927.

A mathematical examination of the recent work by Somigliana. [See Abstract 1661 (1927).] E. F.

METEOROLOGY AND GEOPHYSICS.

563. Dependence of the Turbulence Factor of the Wind on the Vertical Temperature Distribution. F. M. Exner. *Akad. Wiss. Wien, Ber.* 136. 2*a*. *No.* 7. *pp.* 453–460, 1927.

Reference is first made to results obtained by Richardson [see Abstract 1018 (1925)]. After a preliminary discussion of possible air movements with a vertical density gradient, and next with various temperature gradients, mathematical relations are established connecting the turbulence factor with the temperature gradient and the variation of wind speed with height. From the mean values obtained for wind and temperature at different heights on the Eiffel Tower and at lower levels in Paris, the mathematical relations are tested and a fair agreement is obtained which might be improved if individual values were used and not mean values. Finally, the variation of wind speed with height is considered when a temperature inversion exists at the ground. R. S. R.

564. Variation of Eddy Viscosity with Wind Velocity and Season. H. M. Treloar. *Roy. Meteorolog. Soc., J.* 53. *pp.* 439–445, *Oct.*, 1927.

The seasonal variation at Melbourne of the eddy viscosity in the layer between 50 and 150 metres above the ground is discussed and an attempt made to determine the quantitative relationship connecting eddy viscosity with wind velocity and with the difference between air and ground temperature. The basis of the method is the assumption that the frictional resistance to the movement of the air over the ground is proportional to the square of the velocity and that the coefficient in this relation is a universal constant. The eddy viscosity is determined by comparing the up-gradient of wind velocity with the frictional resistance. The fundamental equation is $\left[c\frac{dV}{dz}\right]_{z=0} = K\rho V_s^{2}$. Here c is the eddy viscosity, V the horizontal velocity of the wind, V_s the value of V at the earth's surface, K the coefficient of surface friction, ρ the density of the air. The expression on the left-hand side of the equation represents, by definition, the rate of downward transfer of horizontal momentum, that on the right the frictional force of the wind on unit area. For the present paper K is taken as 0·0023, and the value adopted for V_s is the wind at 50 metres, reduced by 5 %. Judging from Dobson's observations, this is equivalent to the wind at 30 metres. The up-gradient dV/dz was estimated from the difference of velocities at 150 and 50 metres as deduced from pilot-balloon observations at 100 and 200 metres. Observations for each of the 36 months beginning January, 1922, were obtained by the pilot-balloon method with single theodolite and rangefinder. The eddy viscosity (c) is that defined by Richardson, such that $c dV/dz$ is the downward flux of horizontal momentum in a fixed azimuth. A simple method of determining mean values of c is discussed. The seasonal variation of c at a height of 100 metres at Melbourne for different wind velocity classes is given. The eddy viscosity is found to be represented fairly well by the empirical equation $c/\rho = 70V + 7VT$, where V is the wind velocity at 50 metres, T the difference of temperature in ° F. between surface soil and air at 10 ft., and ρ the density of the air. The results are tabulated. [See Abstract 164 (1916).] E. F.

565. Range of Atmospherics. Report from the Committee on the Relation between Atmospherics and Weather. *Roy. Meteorolog. Soc., J.* 53. *pp.* 327–388; *Disc.*, 389–400, *Oct.*, 1927.

The report deals with the results obtained by 48 observers listening to a broadcast talk and to which the time incidence of individual atmospherics can be referred. The duration and intensity of the disturbances were noted. The data were tabulated to give (*a*) observations with complete simultaneity without adjustment, and (*b*) observations where one time unit allowance is allowed for the adjustment of the personal error. The place of origin of individual atmospherics was recorded and a "disturbance index" given, *i.e.*, the relative number of atmospherics per unit time referred to 100 for the most disturbed evening. The weather in the region of the atmospheric "fixes" was found from weather charts. In some cases atmospherics were traced as originating at clearly defined cold fronts or regions of thunderstorm activity. It was concluded that (1) the effective range of reception of very many atmospherics heard on normal broadcast receivers exceeds 3000 km. and reaches at least 7000 km.; (2) atmospherics of range below 200 km. are not shown by any evidence; and (3) cold fronts are of great importance in the origination of atmospheric disturbance. In the *Discussion*, **A. G. Lee** described experiments showing that atmospherics which disturb long-distance commercial reception are not of short-distance origin, seeing that the distribution in azimuth is not uniform. **J. A. Slee** considered that for seagoing conditions most of the atmospherics heard were not of very long range. **G. C. Simpson** suggested the upper air as a source of atmospherics. **R. Bureau** supplied observations and diagrams to illustrate his view that atmospherics are a local consequence of instability. **T. L. Eckersley** suggested that some of the differences between the Committee's results and those of Bureau might be due to differences of wave-length. The Committee replied to the discussion. R. S. R.

566. Monthly Mean Values of Radiation from Various Parts of the Sky at Benson, Oxfordshire. W. H. and L. H. G. Dines. *Roy. Meteorolog. Soc., Mem.* 2. *No.* 11. [8 *pp.*], *Nov.*, 1927.

The quantity measured was the equivalent radiative temperature of that part of the sky from which radiation falls on the thermopile, and for each complete observation seven readings were required, six being from annular elements of the sky at altitudes 15° apart and one from the surface of a grass field. Assuming Stefan's constant, σ, to be $110 \cdot 9 \times 10^{-9}$ gm.-cal. per cm.^{2} per day and using the equation $Q = \sigma T^4$, values of Q are tabulated for each zone in monthly and yearly means for (1) clear skies and (2) overcast skies for long and short wave radiation.

For long-wave radiation there will not be an error more than 1 % to 2 % after reflection from the mirror, but for short-wave radiation the error will be greater. A correction has to be applied to the results, since the observations were mostly taken in the afternoon. For long-wave radiation from clear skies the position of the sun has little effect, but the surface temperature is of more importance; for short-wave radiation, however, the position of the sun does have some effect. For long-wave radiation there is a small increase from the zenith to 30° and a large increase from 67°·5 to 82°·5. For overcast skies the radiation is closely that expected from a black body at the same temperature as the clouds. The amount of diffuse radiation depends on the thickness of the cloud layer, and decreases as the angular distance from the zenith increases. The radiation from the hemisphere is almost exactly that at a zenithal distance of 52°·5, a value in good agreement with L. F. Richardson's theoretical value of 54°. R. S. R.

567. Progress of Meteorology since Confederation. J. Patterson. *Roy. Astron. Soc., Canada, J.* **21**. *pp.* 333–337, *Nov.–Dec.*, 1927.

The author deals with the historical development of meteorology, tracing the changes from weather lore to the beginning of the study of the physics of the atmosphere, which started with the discovery of the barometer. In the last sixty years, with the development of the weather chart, there have been first an extension of the area of the globe over which daily observations have been made and later the investigation of changes in the upper atmosphere. R. S. R.

568. Two Unusual Meteor Phenomena. K. Bohlin. *Ark. f. Mat. Astron. och. Fysik, Stockholm,* **20***a*. *No.* 2. [6 *pp.*], 1927.

Details are given of the appearance, path and deviation of two very unusual meteors seen at Stockholm. The first, seen on Sept. 19, 1925, showed on the photographic record enhanced spots of light along its track instead of the more common uniform streak of light, some spots of circular shape, and one showing a more gradual growth and decay, but with two brighter spots during the growth. The second, seen on Oct. 19, 1925, travelled on a curved track and was of shorter duration, but it gave evidence of a right-handed rotatory motion. The similarities of these with another meteor, seen at Arosa on Oct. 26, 1925, are dealt with. H. S. R.

ASTROPHYSICS.

569. Motion of Gases in the Sun's Atmosphere. S. R. Pike. *Roy. Astron. Soc., M.N.* **88**. *pp.* 3–30, *Nov.*, 1927.

Calculations are given of the radiative force exerted by a square area of the photosphere at any given temperature upon an atom at any given point in the chromosphere. Strictly speaking, the expressions found apply only to an atom of the Ca^+ type; but a great deal of the work holds good approximately for atoms of any type whatever, provided they are supported by radiation pressure. The vertical instability, due to the Doppler effect, which was first pointed out by Milne, is found to have a horizontal counterpart. An atom moving upwards is accelerated horizontally, resulting in a rapid dispersal of upward-moving clouds; and an atom moving downwards and towards the sunspot is retarded, so that a limiting velocity is attained, of the order 50 to 100 km./sec. The observed motions of gases in the chromosphere are considered in the light of the preceding calculations; and it is found that nearly all of them can be satisfactorily accounted for. One or two observations, however, remain which it does not seem possible to explain by means of radiation pressure alone. It is suggested that if specified regions of the sun can exert forces of any other nature than this upon atoms in the chromosphere, then these forces should be found acting by themselves over " invisible " sunspots. AUTHOR.

570. The Relative Intensity of the Principal Doublet (HK) and the Diffuse Doublet (X) in the Spectrum of the Calcium Chromosphere. C. Davidson. *Roy. Astron. Soc., M.N.* **88.** *pp.* **30–33,** *Nov.,* **1927.**

The chromospheric spectrum has been photographed in the regions near H and K and the infra-red doublet of Ca^+ with a simultaneous exposure enabling a direct comparison to be made. The absolute intensity of 8542 is found to be somewhat greater than that of K at moderate levels. AUTHOR.

571. Diffraction of Solar Images at a Focus. M. Hamy. *Comptes Rendus,* **185.** *pp.* **1230–1234,** *Dec.* **5, 1927.**

The diffraction of the image of a finite star due to a rectangular stop is considered. The paper is entirely mathematical. A. Wh.

572. Spherical Polygons. T. Banachiewicz. *Comptes Rendus,* **185.** *pp.* **1116–1117,** *Nov.* **21, 1927.**

Many problems involve the resolution of spherical polygons, which are usually treated with reference to their constituent spherical triangles. Certain properties of spherical polygons are treated by the use of suitable matrices. A. Wh.

573. Theory of Perturbations. J. Renaux. *Bull. Astronomique,* **5. 4.** *pp.* **327–373, 1927.**

A convenient method for dealing with perturbations is developed. In the first section of the paper the method is described and is later applied to observations of the planet 451 Patentia. A. Wh.

574. Velocity of Transmission of Gravity. L. Becker. *Roy. Astron. Soc., M.N.* **88.** *pp.* **93–97,** *Nov.,* **1927.**

The problem of two bodies modified by the assumption of a finite velocity of transmission of gravity is worked out and the perturbations considered. It is concluded that there is no evidence that gravity is propagated with anything but infinite velocity. A. Wh.

575. Variability of the Rotation of the Earth. R. T. A. Innes. *Roy. Astron. Soc., Canada, J.* **21.** *pp.* **342–348,** *Nov.–Dec.,* **1927.**

The author reviews the checks which can be employed on the earth's rate of rotation, particularly the motion of the moon, the eclipses of Jupiter's Satellite I, and the transits of Mercury. He refers to Newcomb's suspicion that the moon's fluctuations were due to a change in the length of the day, to Glauert's confirmation of this, to Brown's explanation of the fact by changes in the direction of the earth's and other magnetic fields, and to Eddington's setting of this view. He considers that the evidence points strongly to a continuous lengthening of the period of the day, interrupted by irregular variations, and suggests that for confirmation a mean length of the day should be found from as long a period of observations as can be safely used and the error of the resulting time from month to month ascertained. R. S. R.

576. Third Satellite of Jupiter. G. Rougier. *Comptes Rendus,* 185. *pp.* 1444–1445, *Dec.* 19, 1927.

Observations of the third satellite of Jupiter show that recognisable markings are present, and it appears that the period of rotation is equal to the period of revolution in its orbit. A. Wh.

577. Identification and Orbit of the Planet 658 Asteria. B. Asplind. *Astron. Iakttagelser Undersökning., Stockholm,* 11. 3. [89 *pp.*], 1927. *In German.*

A complete account is given of the discovery of this minor planet at Heidelberg in 1908, the methods of determining its orbit and the perturbations which affect it, and the observations made at its opposition in 1926–27. M. A. E.

578. Distribution of Brightness in a Field of Self-Luminous Lines in a Plane. E. J. Perepelkin. *ZS. f. Phys.* 45. 11–12. *pp.* 847–850, 1927.

Given a plane cluster of lines with numerous independent parameters, the density of the distribution of the lines in different regions of the plane varies according to the structure of the function. Presupposing that each line radiates its own light, the author is able to picture the distribution of the brightness in the plane. The theory is applied to solving the question of the distribution of brightness in the extra-focal stellar image given by an objective with considerable chromatic and spherical aberration. E. F.

579. Physiological Errors in Determining Stellar Magnitudes. J. Mascart. *Bull. Astronomique,* 5. 4. *pp.* 319–326, 1927.

Following the work of Gonnessiat on the personal equation in astronomy, the Observatory of Lyons is studying the physiological errors which are liable to interfere with the accuracy of the results in the visual observations of the variable stars and general stellar photometry. The present paper reviews briefly the work done here, and compares it with the work of Waterfield and others. A distinction is made between (1) sensibility to light, which is tested by the faintest light perceptible to the eye, and (2) sensibility to differences of intensity in light. Error arises chiefly from the different sensibility of different parts of the retina, and normal eyes are alike in this respect. Results are tabulated which show how light-estimates are affected by the positions of the stars with regard to the eye (whether the star observed is to the right or the left, above or below the comparison star), and also by their distances apart. Various suggestions of method are discussed, and although much useful work has been accomplished, much remains to be done, since every disturbing factor must be isolated and investigated in order to reach definite results. M. A. E.

580. Luminosities, Parallaxes and Motions of B-Type and A-Type Stars. B. Lindblad and C. Schalén. *Ark. f. Mat. Astron. och Fysik, Stockholm,* 20*a*. *No.* 7. [25 *pp*.], 1927.

The stars between B8 and A5, which have enormously strong absorption in the Balmer lines of hydrogen, and are most commonly referred to as the A-type stars, in several respects do not represent a truly homogeneous or natural group of stars, especially as the A4 and A5 stars are markedly less luminous and appear to have stronger affinities with F stars. The authors have therefore adopted a new method of classification, and use as a characteristic for subdivision the width of the wings in the hydrogen lines and the colour in objective prism spectra; and they restrict the class to the stars between B8 and A3, calling them " hydrogen stars." All show a decrease of width in the H-lines with increasing luminosity. The classification is only preliminary, but it is very convenient in practice and is applicable to faint stars. The radial and tangential velocities of these stars, taken from various sources, have been compared, and their absolute magnitudes, parallaxes and velocity-ellipsoid determined. A catalogue embodies the results for 399 stars. M. A. E.

581. Period of 27 Canis Majoris. O. Struve. *Astrophys. J.* 66. *pp*. 113–121, *Sept.*, 1927.

Since this southern star can be observed at the Yerkes Observatory only when near the meridian, there are theoretically three periods which will satisfy the observations: one is the long period of 1165 days, while the other two periods are equal to one sidereal day plus or minus 1 minute and 14 seconds. Check observations taken during the same night permit one to discard the longer one of the two short periods. The shorter one remains possible, although there is some evidence against it. The appearance of the absorption lines is not what would be expected in a binary of such short period. There are no other truly double stars of spectral type B with periods shorter than 1·3 days. The eccentricity of 27 Canis Majoris would seem to be greater than would be expected in so close a binary. On the other hand, the large mass resulting from the long period is so improbable that the possibility of a one-day period must be kept under consideration. The question could be solved by means of observations taken in different hour-angles during the same night and covering a sufficiently long interval of time. Such observations could best be made at a southern observatory, where the star rises high enough above the horizon. [See also Abstract 3071 (1927).] AUTHOR.

582. Zero Point of the Period-Luminosity Curve. K. G. Malmquist. *Ark. f. Mat. Astron. och Fysik, Stockholm,* 20*a*. *No.* 4. [7 *pp*.], 1927.

The very strong correlation between the periods and the absolute magnitudes of Cepheid variables affords an excellent method for finding the distances of celestial objects. The curve which gives the connection between period and luminosity is found to have the same form everywhere, but the weak point is the determination of its zero point. Originally this was determined from the parallaxes of eleven Cepheids only, found from their proper motions; an improvement was made by R. E. Wilson, who included 70 Cepheids in his investigation; and this has been tested by comparing the result for some globular clusters with their distances derived from Kapteyn's method of the absolute magnitude curve. But distances derived in this way by different investigators show very different results. A better way is to select a special group of stars in a cluster, belonging to a limited range of colour, and to find their absolute magnitude curve by a method which will be more fully discussed in a future paper. The result is to correct Shapley's zero point by an amount which requires that his distances should be reduced by a factor of 0·7. M. A. E.

583. Relations between Period, Luminosity and Spectrum among Cepheids. H. N. Russell. *Mt. Wilson Observat., Contrib. No.* 339. *Astrophys. J.* 66. *pp.* 122–134, *Sept.*, 1927.

If it is assumed that the median total luminosity of periodic variable stars follows the observed mass-luminosity law, and that the variation of any given type arises from a dynamical oscillation of some definite sort, it follows that the existence of a relation between period and luminosity demands one between period and spectral class, and *vice versa*. For the normal Cepheids, the observed change in mean spectrum with period is in excellent agreement with that computed from the period-luminosity curve. If variability of long period arises from a dynamical oscillation, the relation between period and density must be roughly the same as for the Cepheids. For the cluster variables, the period corresponding to a given density must be shorter than for the Cepheids, and the properties of the dynamical system must be rather peculiar. Periodic variables decidedly fainter in absolute magnitude than the period-luminosity curve indicates should be much redder than Cepheids of the same period, if they owe their variability to dynamical oscillations. No cases of this sort are known among the galactic stars. AUTHOR.

584. Orbit of the Spectroscopic Binary 95 o Leonis. O. Struve and W. W. Morgan. *Astrophys. J.* 66. *pp.* 135–138, *Sept.*, 1927.

The orbital elements of this spectroscopic binary, which has double lines, were derived from 35 spectrograms, of which 33 were obtained with the one-prism Bruce spectrograph of the Yerkes Observatory. $P = 6^d{\cdot}6254$; $\gamma = -20{\cdot}4$ km./sec. ; $e = 0{\cdot}02$; $K_1 = 57{\cdot}6$ km./sec.; $\omega = 4^\circ{\cdot}1$; T = 1927 March 1·115 U.T.; $m_2/m_1 = 0{\cdot}72$; $(m_1 + m_2) \sin^3 i = 1{\cdot}8 \odot$; $a_1 \sin i = 5{,}250{,}000$ km. AUTHORS.

585. Orbit of the Spectroscopic Binary 6 π Scorpii. O. Struve and C. T. Elvey. *Astrophys. J.* 66. *pp.* 217–221, *Oct.*, 1927.

The orbital elements of this spectroscopic binary were derived from 48 spectrograms obtained at the Yerkes and Dearborn Observatories. The spectra of both components have been measured. P = 1·571 day; $\gamma = -3$ km./sec.; $e = 0{\cdot}05$; $K_1 = 138$ km./sec.; $K_2 = 180$ km./sec.; $\omega = 90^\circ$; T = 1927. June 15·523 U.T.; $m_2/m_1 = 0{\cdot}77$; $(m_1 + m_2) \sin^3 i = 5{\cdot}2 \odot$; $a_1 \sin i = 3{,}000{,}000$ km. AUTHORS.

586. Statistical Study of Binaries. E. A. Kreiken. *Roy. Astron. Soc., M.N.* 88. *pp.* 101–108, *Nov.*, 1927.

The space distribution of the major axes of binaries is analysed. Even though no discrimination between the real and spurious directions is usually possible, the curves derived prove the distribution to be distinctly directional. There is a tendency to parallelism with the Milky Way and a maximum frequency in direction $\lambda = 330^\circ$. It is also probable that all binaries have a rotation in a similar direction. A. Wh.

LIGHT.

587. Quantitative Relations in Colour Theory. E. Haschek. *Akad. Wiss. Wien, Ber.* **136. 2a.** *No.* **7.** *pp.* **461–468, 1927.**

Revises the work of König and Dieterici (1892) and of Exner (1910). Concludes that we are not yet in a position to evaluate the data numerically. A. D.

588. Application of Gauss's Law to the Duration of Twilight Colours. P. Barreca. *Arch. des Sciences,* **9.** *pp.* **307–315,** *Sept.–Oct.,* **1927.**

Reference is made to values obtained earlier [see Abstract 1664 (1927)] regarding the duration of colours seen on clouds or dust at sunrise or sunset, and the mean duration of each colour observed is proportional to the wave-length and to a number characteristic of the order of the spectrum. By statistical analysis it is found that the values for the duration are grouped around mean values according to Gauss's law of mean squares with the usual restriction that the magnitude of any difference never exceeds a certain value. R. S. R.

589. Transparency of Coloured Quartz for Ultra-Violet Light. K. Tsukamoto. *Rev. d'Optique,* **6.** *pp.* **478–481,** *Nov.,* **1927.**

The transparency of a number of different samples of quartz (smoked, grey, black, rose, green and milky quartz, false topaz, amethyst, etc.) has been studied by placing each sample before the slit of a small spectrograph, having a quartz eyepiece. A condensed spark between aluminium electrodes was used as source and photographic tests made. The transparency in the ultra-violet regions for the various kinds is set out in detail. It is greater than expected, depends largely upon the nature of the constituents, and is independent of the transparency in the visible region. Further tests are in progress. R. S. R.

590. Pleochroism of Tourmaline. P. Leroux. *Comptes Rendus,* **185.** *pp.* **1456–1458,** *Dec.* **19, 1927.**

The author's object is to verify how far absorption in crystals is independent of the direction of propagation and is affected solely by that of the luminous vector, as is generally admitted and borne out by theory in the case of weak absorption. The measuring apparatus consisted of a photoelectric cell combined with a quadrant electrometer, permitting the determination of the coefficient of absorption in the visible spectrum and at the beginning of the ultra-violet. The source of light was a mercury quartz arc fed by accumulators, the different rays being selected by suitable screens. The crystal is placed on a divided circle in front of the cell diaphragm, and can be removed and accurately replaced by means of a special device. A system of lenses gives a parallel pencil perpendicular to the faces of the crystalline lamina. A nicol may be fixed in front of the crystal. The assumed definition of the coefficient of absorption K is that given by the ratio $I = I_0 e^{-Kd}$, I being the intensity of the incident radiation and I_0 the intensity of the radiation after a passage in the substance of *l* centimetres. The experiment was made with two very pure laminæ of blue tourmaline cut as near as possible to each other from the same crystal and respectively perpendicular and parallel to the axis. Measurements on the lamina perpendicular to the axis lead to the ordinary coefficient of absorption K_0 for a luminous vector perpendicular to and a direction of propagation parallel to the axis. Measurements on the lamina parallel to the axis lead to values which vary with the orientation of the lamina. A summary of the experimental results leads to the following conclusions: (1) Where the absorption is not very small it cannot be conceded, without making an inadmissible approximation, that K_0 is independent of the direction of propagation; (2) K_0 is smaller for light propagated in the direction of than for that perpendicular to the axis. E. F.

591. Colour Correction of an Achromatic Doublet. T. T. Smith. *J.O.S.A. and R.S.I.* 15. *pp.* 247–256, *Nov.*, 1927.

Gives some corrections to results stated in a previous paper on this subject [see Abstract 1067 (1925)]. In the present paper the author calculates the visual efficiency (for light of colour temp. 6000° K.) of an achromatic doublet constructed from Schott 0–60 and 0–103. For various values of H^2/J (H = radius of aperture and J = focal length of the doublet), the limits of λ and f/F within which the visual efficiency does not change by more than 5 % are calculated (λ is the wave-length for which J is a minimum, *f* and F are the focal lengths of the elements). The effects of changes in the colour curves of the glasses used are investigated and the efficiency is calculated for a number of combinations.

J. W. T. W.

592. Use of a Photoelectric Pile for Measurements of the Reflecting Power of Opaque Minerals. J. Orcel. *Comptes Rendus,* 185. *pp.* 1141–1143, *Nov.* 21, 1927.

For the measurements the author used a type of cell and experimental method employed by F. Toussaint. Polished sections of the metals to be tested were placed on a microscope such as is used for visual inspection of the surfaces and the light reflected is compared with that from one of two standards, (1) galena for absorbing minerals and (2) blend for transparent minerals, the light being received directly on the group of photoelectric cells. For anisotropic minerals the reflecting power differs in different directions and polarised light is employed. Numerical values are given for one series of tests. It is possible by this method to distinguish mineral samples where chemical analysis is inapplicable.

R. S. R.

593. Electrical Response to the Retina in Different Types of Cold-blooded Animals. A. B. Meservey and E. L. Chaffee. *J.O.S.A. and R.S.I.* 15. *pp.* 311–330, *Dec.*, 1927.

The purpose of the work was to compare the responses obtained from eyes of different types with those already obtained from frogs, and to test the hypothesis advanced to account for some of the previous results. Alligators, turtles, horned toads and Florida chameleons were used and many further readings obtained with frogs. These different retinas have cones only for turtles, toads and chameleons, cones and rods for frogs, and varying proportions of both for alligators. It is thus possible to investigate whether different parts of the response curves can be attributed to the rods and cones respectively. The experimental method is essentially that used for earlier tests [see Abstract 488 (1923) and 812 (1925)]. It was found that in general the normal response curves for moderate ranges of intensity of stimulating light were roughly similar for all the eyes studied, but there are significant differences in the shape of the response curves for cone and mixed retinas and in their intensity relations. The results support the view that cones are the chief instruments of vision at high intensities and rods at low intensities. It is suggested that the distinction between rods and cones is often too sharply drawn. The authors conclude that from the experiments they cannot decide definitely the correct explanation of successive maxima in response curves for the frog for short exposures, but the hypothesis that rods and cones are responsible for the first two maxima is consistent with the results obtained if some gradation between rod and cone responses is admitted; the third maximum is almost certainly due to superposition of " off " effect. R. S. R.

594. A New Interferential Method for Measuring the Indices of Liquids. (Miss) O. Jasse. *Comptes Rendus*, 185. *pp.* 1268–1269, *Dec.* 5, 1927.

The optical lengths of two equal thicknesses, one taken in the liquid and the other in air, are compared by observing the two systems of rings at infinity produced by the passage of light across a narrow trough with parallel faces, the inner ones being coated with transparent films of silver. The lower half of the trough is filled with the liquid and the upper part with air. Mathematical details are given, and it is shown that the method is capable of great precision, that only a very small quantity of the liquid is required, and that, unlike other interferential methods, which only increase the accuracy of measurements carried out by other means, the whole measurement can be carried out with the one apparatus. H. N. A.

595. Refractive Index of Quartz. W. R. C. Coode-Adams. *Roy. Soc., Proc.* 117. *pp.* 209–213, *Dec.* 1, 1927.

Shows how, by reversing the process used by Drude, a new formula for the refractive index of quartz can be obtained from the ultra-violet frequencies calculated from the optical rotations as recently determined by Lowry and Coode-Adams. The formula finally arrived at is $n^2 = 3\cdot53445 + \frac{0\cdot008067}{\lambda^2 - 0\cdot0127493} + \frac{0\cdot002682}{\lambda^2 - 0\cdot000974} + \frac{127\cdot2}{\lambda^2 - 108}$; this agrees almost perfectly with the experimental results of Gifford for wave-lengths ranging from 2144 to 7951, and provides an adequate representation of the most trustworthy data for the infra-red. The constant term 3·53445 in the new formula should be equal to the specific inductive capacity. Thornton gives 3·78 for this and Schulze 3·20 for $\lambda = 75$ cm. H. N. A.

596. Optical Effects Presented by Quartz under Piezoelectric Vibration. R. Moens and J. E. Verschaffelt. *Comptes Rendus*, 185. *pp.* 1034–1036, *Nov.* 14, 1927.

A piece of quartz 8 mm. long in the direction of the electric axis, 12 mm. in the direction of the optic axis, and 34 mm. in the direction normal to both axes, was placed in the oscillating circuit of a triode valve, the plate voltage being 400 and the frequency about 450,000. The quartz was placed between Nicols and the transmitted light examined spectroscopically. Looking along the optic axis, and observing in the continuous spectrum a dark band due to rotary polarisation, it was found that on turning on the field that band was instantaneously and considerably displaced towards the red. If the band was in the green, it moved as far as the yellow, or even beyond it, at the same time getting feebler. The phenomenon only took place at exact resonance. The authors attribute it to a change in the rotatory power of the quartz. No such displacement could be produced by compression or by an intense static electric field. With monochromatic light an instantaneous lighting up or obscuring of the field may be produced. The authors suggest applying this observation to the solution of the television problem. E. E. F. d'A.

597. Optical Apparatus Providing Rotation of Images. M. Hamy. *Comptes Rendus*, 185. *pp.* 978–979, *Nov.* 14, 1927.

Two lenses are arranged along a common optical axis at a distance apart, four times the focal length of each. In fitting them to the telescope, the eyepiece is withdrawn and the carrier of the lenses inserted with the focal plane of one lens coincident with the micrometer thread in the telescope and the eyepiece then replaced. To obtain rotation of the images a total reflecting rectangular prism is inserted between these two special lenses with the common axis of the lenses parallel to the hypotenuse of the prism and at such a distance from it that a ray incident along this axis remains along it after passing through the prism. The lenses used were of 4·5 cm. focal length and 0·8 cm. diameter. R. S. R.

598. The Aplanatic Telescope and its Adaptations. H. Chrétien. *Comptes Rendus*, 185. *pp.* 1125–1127, *Nov.* 21, 1927.

Consideration is given to the case in which an aplanatic telescope has one mirror replaced by another to give greater magnification. An expression is obtained for the coma characteristic of the combination in terms of the ratio of the diameters of the mirrors, and the ratio of their focal lengths and various applications of the formula are examined. R. S. R.

599. Limiting Illumination in Monostatic Telemetry. A. de Gramont. *Rev. d'Optique*, 6. *pp.* 465–469, *Nov.*, 1927.

Measurements were made by two exactly similar instruments, in one case by the method of coincidences and in the other by a stereoscopic method, on the brightness of the sky, at twilight on occasions where the horizon was clear and clouds were absent. Readings were taken at minute intervals alternately in the two instruments. Details are given of the apparatus used. It was found that by the method of coincidences results could be obtained down to an illumination of 1×10^{-4} bougies/cm.^{2}, but the stereoscopic method acts conveniently to $0{\cdot}25 \times 10^{-4}$ and can work even to $0{\cdot}1 \times 10^{-4}$ bougies/cm.^{2}. R. S. R.

600. Interferometer for the Control of Optical Surfaces. G. Mabboux. *Rev. d'Optique*, 6. *pp.* 470–477, *Nov.*, 1927.

The author describes an interferometer, studied and constructed two years ago at his laboratory, which permits the control of optical surfaces without putting them in contact or touching the standard with the hands. The instrument is very rapid in action, exceptionally stable, and permits the control of a series of pieces with great rapidity without cleaning and without risk of scratching. Photographs illustrate the details of the apparatus. R. S. R.

601. A Frontal Focometer. *Rev. d'Optique,* 6. *pp.* 435–441, *Oct.,* 1927.

A new form of instrument is described which allows the determination of the frontal power of spectacle glasses required by eyes under examination. The term frontal power is defined. J. K.

602. Silvering Glass Plates for Optical Instruments. J. J. Manley. *Phil. Mag.* 4. *pp.* 1322–1323, *Dec.,* 1927.

In method 1 the chemically clean glass plate and the two silvering solutions are cooled with ice, and kept cold during the whole process, which proceeds very slowly and gives a very firm film. In method 2 no polishing is needed, room temperature is used, and after 10–15 minutes only the silvering is arrested by a gentle stream of water. The plate is rinsed with distilled water, rapidly dried and is then ready for use. H. N. A.

603. Use of the Spectroscope in Regulating Fringes of Superposition. G. Simon. *Comptes Rendus,* 185. *pp.* 1269–1270, *Dec.* 5, 1927.

A parallel beam of white light, which has passed through the Perot and Fabry plates, falls on the slit of a spectroscope, and straight bands are observed which are very distinct when the difference in the thicknesses is of the order $100\ \mu$. If the adjustment of the plates is imperfect the bands are curved or indistinct. The author describes how the appearance of the bands changes when the difference of thickness is gradually altered, so as to pass through the value zero. The appearance of the bands indicates the sign of the difference between the two thicknesses compared. If this arrangement is used with the method previously described [*ibid. p.* 1124, *Nov.* 21, 1917] bands are observed in the neighbourhood of superposition, at about $100\ \mu$; the variation in the appearance of these as superposition is approached is described. When the distance between the bands has been made large enough the spectroscope can be replaced by a lens to observe the rings previously described. H. N. A.

604. Vacuum Spectrograph Design. R. A. Sawyer. *J.O.S.A. and R.S.I.* 15. *pp.* 305–308, *Nov.,* 1927.

Construction and adjustments of a 1-metre vacuum spectrograph for use in regions below $\lambda 3000$. A. D.

605. New Sources of Light. F. Skaupy. *Zeitschr. f. tech. Phys.* 8. 12. *pp.* 558–560, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.,* 1927.

The author deals first with vacuum tubes containing N_2 and CO_2 and methods which may be used to eliminate residual gases from the electrodes. For N_2 he uses for one electrode a cylinder of sheet iron open at the end nearer the other electrode and closed at the other end with a conical cup containing sodium nitride. For CO_2 he uses an Al sheet electrode impregnated with $MgCO_3$, and a still greater improvement is obtained by the addition of He to bring the gas pressure up to 2 mm. New sources for ultra-violet light were also examined, and particularly glow lamps made of special glass transparent to the particular ultra-violet wave-lengths required for therapeutic purposes. R. S. R.

606. A Study of a Fringe System of Thick Plates. A. Aubertin. *Rev. d'Optique,* 6. *pp.* 445–464, *Nov.,* 1927.

The fringes studied are the result of interference of rays which are reflected twice from the faces of a thick plate, for after the first reflection the bundle of rays are thrown again on to the plate by means of a total reflecting prism. The reflection of the rays by the prism can be done in two ways, for one can turn towards the plate either the face of the hypotenuse or the corner of the rectangular dihedral, and it is the latter case which is investigated here, for the fringes given by this means are more varied. J. K.

607. Diffusion of Light and Visibility. Y. Rocard and P. de Rothschild. *Rev. d'Optique,* 6. *pp.* 353–363, *Sept.,* 1927.

The part played by the atmospheric diffusion of light in relation to visibility is developed by means of a general theory which permits the determination of the relationship between the intensity of diffusion and the coefficient of absorption—a factor relatively easy to obtain experimentally, and the results obtained by this means are in the main applied to projectors. J. K.

608. The Role of Atomic Vibrations in Molecules in the Phenomenon of Light Diffusion. Y. Rocard. *Comptes Rendus,* 185. *pp.* 1026–1028, *Nov.* 14, 1927.

A short theoretical paper based upon modern conceptions of molecular structure. J. K.

609. Passage of Light through a Medium in Motion. Q. Majorana. *Accad. Sci. Torino, Atti,* 72. 3–5. *pp.* 51–55, 1926–1927.

Shows that a simple geometrical construction leads to

$$V_2 = v(1 - n^2) + V_1\sqrt{1 - \frac{v^2}{V_1^2}\left(\frac{1}{n^2} - \frac{1}{n^n}\right)}.$$

This is approximately $V_2 = V_1 + v\left(1 - \frac{1}{n^2}\right)$, the Fresnel-Fizeau relation.

A. D.

610. The Thickness of Spontaneously Deposited Photoelectrically Active Rubidium Films Measured Optically. H. E. Ives and A. L. Johnsrud. *J.O.S.A. and R.S.I.* 15. *pp.* 374–381, *Dec.,* 1927.

Measurements were made of the thin films which deposit in a high vacuum on polished platinum or glass, which are invisible, but which are photoelectrically sensitive to the same extent as thick layers. Plane polarised light, polarised at an azimuth of 45°, was directed on the surface, and the reflected light examined with a Babinet compensator and nicol prism, the shift of the azimuth or phase caused by the film being measured. The theory of the calculations of the thickness has been given by T. C. Fry. The result is that the layer of rubidium formed on glass is about one atom thick, but as the theory may not hold exactly for such thin films, it is possible that the actual thickness may be five or even ten atomic diameters. The effect of such a rubidium film on the optical behaviour of platinum is so small as to lie within the errors of observation, and this could not be measured. H. N. A.

611. Excitation of Polarised Light by Electron Impact. Part II. Mercury. H. W. B. Skinner and E. T. S. Appleyard. *Roy. Soc., Proc.* 117. *pp.* 224–244, *Dec.* 1, 1927.

In Part I, by Skinner, the measurements of the polarisation were, with one exception, qualitative [see Abstract 656 (1927)], the authors now describe quantitative results and have studied the variation of the polarisation with the velocity of the electron stream, which was varied from 9 to 200 volts. The percentage polarisation of the lines dealt with was measured photometrically. They show different polarisation characteristics, some are unpolarised, some polarised with the electric vector parallel to the electron stream and some at right angles. The curves given for the polarised lines show a characteristic variation of the polarisation with the electron speed; there is in all cases a maximum of polarisation for a velocity a few volts above the excitation point, and in most cases there is reversed polarisation for high electron velocities. The various polarisation effects can be interpreted to give information about the dynamics of the collision process between the electron and the mercury atom which is excited by it. H. N. A.

612. Dispersion of Organic Compounds in the Visible and Ultra-Violet Region. K. Feussner. *ZS. f. Phys.* 45. 9–10. *pp.* 689–716, 1927.

Measurements have been made of the refractive power of carbon disulphide, benzaldehyde, acetophenone, nitrobenzene, aniline, and quinoline for series of 33 to 61 lines ranging in wave-length from He 7065·2 to Cd 2573·1 Å.U. The measurements in the visible were made by a photographic method with a 25° prism, with the incident light normal to one face; those in the ultra-violet were made by the method of crossed prisms, a horizontal dispersion being produced by a 60° quartz double prism, and a vertical dispersion by a thin wedge of the liquid between quartz plates. In the cases of benzaldehyde and carbon disulphide, equations were calculated for characteristic vibrations at 1800, 2400, 2800, 3310 and at 1400, 2420 and 3230 Å.U., but this tedious and difficult calculation was not made for the other substances. The refractive index for carbon disulphide was shown to pass through a shallow minimum at 3230 Å.U. in close agreement with the wave-length of maximum absorption given by Bruhat and Pauthenier [see Abstract 716 (1926)]. Attention may be directed to the fact that the characteristic vibration at 2400 Å.U. occurs at a shorter wave-length than the selective reflexion at 2500 to 2600 Å.U. T. M. L.

613. Scattering of Light in Gaseous and Liquid Chlorine. W. H. Martin and A. F. W. Cole. *Am. Electrochem. Soc., Trans.* 49. *pp.* 135–140; *Disc.*, 140–142, 1926.

An intense beam of light from a cerium-oxide cored carbon arc was passed through a glass cross filled with Cl_2 as a liquid or vapour, and the intensity of the scattered light, viewed at right angles to the incident beam, was compared with that of unsaturated ether vapour in a similar glass cross. The vapours were freed from suspended matter, and the scattering is thus a measure of the number, optical density and distribution of the molecules. The polarisation of the scattered light which gives a measure of the optical anisotropy of the molecules, was also measured. For gaseous Cl_2 the scattering is in good agreement with that given by Rayleigh's formula, but for liquid Cl_2 the result is 50 % too high. It is suggested that abnormal scattering near to an absorption band may be the cause. In the *Discussion* the first-named author stated in reply to A. E. R. Westman that scattering in glass was complicated by possible suspended particles or small crystals. [See Abstract 664 (1918)].

R. S. R.

614. Optical Properties of Dispersed Cinnabar (HgS). G. P. Woronkoff and G. I. Pokrowski. *Kolloid Zeits.* 43. *pp.* 78–81, *Oct.*, 1927.

A description is given of the changes brought about in the selective absorption of both transmitted and scattered light by increasing degree of dispersion of sols. A beam of parallel rays is passed through suspensions of cinnabar, and measurements are made with a spectrophotometer in the direction of the beam and at right angles to it. With coarse suspensions the scattered light is of the same colour as the transmitted, while with fine suspension the colours are complementary. Curves are plotted to show the intensity of the scattered light i_λ of different wave-lengths for varying concentration of the sol and for varying diameters of the particles ρ. The results are in accordance with the relations derived mathematically and show that a maximum scattering occurs at definite concentrations which vary with the wave-length. It is shown that for longer wave-lengths $di_\lambda/d\rho<0$ and for shorter wave-lengths $di_\lambda/d\rho>0$, which is in accordance with the observation of the red colour of cinnabar changing with increasing dispersion to the blue opalescence colour.

J. N. P.

615. Illumination in Metal Microscopy. H. S. George. *J.O.S.A. and R.S.I.* 15. *pp.* 295–304, *Nov.*, 1927.

An "ideal method" of illumination is advanced with specific means for its production in metallography. It is shown that it is deleterious to ocular perception and photography to illuminate with rays parallel or even nearly parallel to the line joining the object and the eye or the camera, not only for perception with the unaided eye but through the microscope. In metal microscopy axial light is deleterious because it produces an inferior image of lower resolution and definition and it also neutralises the shading effect of oblique light, thus rendering many details invisible by obliterating relief; therefore axial light should be eliminated and selected portions of the remaining hollow cone manipulated as described. Several types of apparatus are briefly discussed and an improved device is described. The article is illustrated by diagrams and by studies of grain structure in a solid solution. AUTHOR.

616. Use of Photographic Sensitisers in Histological Micrography. E. Calzavara and I. Bertrand. *Rev. d'Optique*, 6. *pp.* 397–430, *Oct.*, 1927.

The authors have found that the use of the customary dyes and of ortho- or panchromatic plates does not give sufficiently detailed evidence for histological preparations because of want of agreement between the absorption spectrum of the coloured element and the sensitivity curve of the plates in the spectral region used for photography. For the best registration there must be absolute agreement. Various sensitisers for the plates were studied, and it was established that cyanines gave excellent dyes and that the best micrographic results arose when one used plates sensitised with this same cyanine. On account of the clear separation of the zones of initial and acquired sensitivity cryptocyanines are the best to use. Particulars are given of the various cyanines and of the technique of microphotography. Various normal and pathological tissues were studied, and it is shown that the results can be greater than those one obtains when using radiations of shorter wave-length, particularly in the ultra-violet, in spite of the increased ability to separate with the frequency of the radiations used. R. S. R.

617. Influence of Light Absorption of AgBr through Adsorbed Ions. K. Fajans, H. Fromherz and G. Karagunis. *Z. El. Chem.* 33. 548–554, Dec., 1927. *Paper read before the Deut. Bunsen Gesell., Dresden, May,* 1927.

In the photochemical sensitising of AgBr by Ag or Th ions we have, besides the acceptor action of these ions, also an influencing of the primary process by the absorption of light. The colourless Ag or Th ions absorb into the ultra-violet region. The adsorbed ions alter the field of the superficial bromine ions. The influence of adsorbed Th ions is only about half that of adsorbed Ag ions. Na ions are only slightly deforming, and there is no evident shift of the absorption of AgBr. A. D.

618. The Latent Image. Tentative Hypothesis. A. P. H. Trivelli. *Eastman Kodak Co. Research Lab., Comm. No.* 313. *Frank. Inst., J.* 204. *pp.* 649–662, *Nov.*, 1927. *Phot. J.* 68. *pp.* 14–20, *Jan.*, 1928.

The fact that selenium and several other substances, including silver halides and silver sulphide, are photoconductive as well as photoelectric, taken together with the facts that in the silver halide grain silver sulphides and perhaps silver exists and that these appear to be more photoelectric than the surrounding silver halide, have led to the conclusion that the photoelectric effect and the photoconductivity may play a part in the formation of the latent image. It is assumed that when light falls on the silver halide grain containing a sensitising speck of silver sulphide or silver, the greater photoelectric effect of silver sulphide or silver compared with that of the silver halide produces a difference in potential between these and that in some way yet unknown the photoconductivity produced by the light action causes an electrolytic deposition of silver in the neighbourhood of the speck, hence increases its size, and in consequence the developability of the grain. Such an effect does not preclude the simple photochemical decomposition of silver halide by light to give silver nor the possibility of silver sulphide serving as a hydrogen absorber. Qualitatively there seems to be a correlation between the intermittency effect and the failure of the reciprocity law and the latent image formation. A. D.

619. Fog Correction of Photographic Densities—A Sensitometric Study. H. A. Pritchard. *Eastman Kodak Co. Research Lab., Comm. No.* 310. *Phot. J.* 67. *pp.* 447–459, *Nov.*, 1927.

The Wilsey fog correction, based on the assumption that the mass of silver developing as fog is proportional to the mass of silver unaffected by exposure, neglects several factors which have an appreciable effect unless the fog is small. In the present work experimental fog correction functions are obtained by a study of the growth of fog at long development times after image density has been practically completely developed. These give more consistent sets of corrected sensitometric data than previous methods of fog correction. The Wilsey method appears to give satisfactory results provided image density can be practically completely developed before fog reaches a value of 0·5. The Bloch method of measuring fog in a small protected area in the centre of each density indicated that the influence of reaction products upon development is practically negligible with the developer used, Elon-hydroquinone X-ray formula. It is found possible by prolonged development to develop all the silver in the film as fog. However, the density of maximum fog is considerably less than maximum image density. The reversal effect in the lower exposures observed on positive film at long development times is found to remain at complete development of all the silver in the film. The large variations in photometric equivalent are believed to contribute considerably to the failure of the Wilsey fog correction under extreme conditions. A. E. G.

620. The "Cadastro" Apparatus for Aerial Plate Photography provided with an Extra-Rapid Object Shutter. *Rev. d'Optique,* 6. *pp.* 431–434, *Oct.*, 1927.

A new form of register is described to be used in aerial photography where great precision is required. J. K.

621. New Photographic Problems. A. Steigmann. *Kolloid Zeits.* 43. *pp.* 400–402, *Dec.*, 1927.

Problems suggested by Shepherd's researches: the relation of the liability of sulphur in the impurities of the gelatine to desensibilising; the adsorption relations in different silver halides; the sulphur-activating action of the different silver halides. A. D.

622. Photographic Inversion and Solarisation. H. Belliot. *Comptes Rendus,* 185. *pp.* 1463–1465, *Dec.* 19, 1927.

Explained, on Perrin's model (*deuxième Conseil de Chimie de l'Institut international de Solvay, p.* 387, 1926), by analogy with the phenomena of fluorescence. A. D.

623. Intermittency Effect in Photographic Exposure. C. E. Weinland. *J.O.S.A. and R.S.I.* 15. *pp.* 337–353, *Dec.*, 1927.

The intermittency effect is investigated with monochromatic light at several wave-lengths between 2537 Å. and 4358 Å. The experimental method is described. The increase of the latent image, as set forth by Brush, is found not to exist, nor are the sector scale and intensity scale curves found to coincide as indicated by Weber. It is observed that the intermittency failure is in the same direction as the reciprocity failure, but of less magnitude. Further evidence is cited indicating that there is an intimate relation between the intermittency and reciprocity failure. For moderately high frequencies of flash the intermittency effect is found to increase exponentially with the ratio of rest to flash, being almost independent of the frequency of flash; but at very low frequencies of flash the effect is dependent on frequency and not on ratio. If the plate is previously exposed, the intermittency failure is found to be deduced, and if this previous exposure brings the latent image up to the foot of the straight-line portion of the characteristic curve, the intermittency effect is almost eliminated. A. E. G.

624. Intensity within Fraunhofer Lines. M. Minnaert. *ZS. f. Phys.* 45. 9–10. *pp.* 610–619, 1927.

Measurements on the hydrogen line Hα and the calcium line K are described. The results are compared with those of Klüber, and the causes of the differences are discussed. For weak lines the total surface of the intensity curve is measured and taken as a measure of the strength of the lines. It is shown that a theory of the Fraunhofer lines on the simple basis of absorption, emission and dispersion does not solve the problems involved. [See Abstracts 2498 (1925); 2842 (1927).] E. F.

625. Light Quanta and Interference. A. J. Dempster and H. F. Batho. *Phys. Rev.* 30. *pp.* 644–648, *Nov.*, 1927.

Interference experiments were carried out in which the source was so faint that effects could be attributed to separate quanta of radiation. The energy radiated in the helium line 4471 Å. from a glow discharge was measured by comparison with a black body, and from the known decay constant of the atomic radiation process, the separation of atomic radiations in line was deduced. With an echelon diffraction grating the characteristic double order pattern was photographed when each quantum of light passed separately through the instrument. Under these conditions it gave rise to a pattern due to simultaneous passage through several steps. With an air film between two parallel plates, interference fringes were photographed in 4471, when the quanta emitted from the volume of the source used were completely separated in time, showing that a single quantum obeys the classical laws of partial transmission and reflection at a half-silvered mirror and of subsequent combination with the phase difference required by the wave theory of light. AUTHORS.

626. Light and Heat Radiation from Incandescent Oxides. F. Skaupy. *Phys. Zeits.* 28. *pp.* 842–846; *Disc.*, 846, *Dec.* 1, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

A note on the selective radiation of transparent and opaque refractory oxides and oxide mixtures which were investigated during heating in a flame over the infra-red range and also over some part of the visible spectrum. The author primarily contrasts the Nernst filament with the Auer lamp as giving invisible and visible radiation. Results of an investigation of bodies giving both kinds of radiation are recorded as well as the results of the effects of variation of selective conditions. Sapphire, ruby, aluminium oxide, pure and also with chromium oxide, titanium oxide, quartz, etc., are all discussed and curves appended. The author postulates three kinds of temperature radiation: (1) The characteristic inner vibration of the atom, such as, in the paper, that shown by oxygen. The wave-length alters little or none with the temperature. (2) Emission bands, which shift towards larger wave-lengths with increase of temperature. Zinc oxide affords an example of the movement of an absorption band from the ultra-violet into the visible spectrum. The colour of the ruby is also likewise explained. (3) A continuous radiation with a maximum at a definite place which is identical with that of a black body of equal temperature. The results are examined mathematically, and a short general discussion is appended. S. G. B.

627. Stationary Waves in Systems in Motion and the Doppler Effect. G. Valle. *Accad. Sci. Torino, Atti*, 72. 6–7. *pp.* 69–81, 1926–1927.

Mathematical investigation of the problems involved leads the author to the conclusion that the attempt to derive confirmation of the theory of relativity from the existence of a transverse Doppler effect appears, even theoretically, unconvincing. An essential fact is that for electromagnetic waves, even according to classical theories, the Doppler effect does not present that asymmetry which has hitherto been deemed a necessary result of the hypothesis that those waves are propagated in an immobile medium. Although in the ether at rest the relative motions occurring between a source and an electromagnetic wave receiver, while kinematically identical, appear to differ from each other, the Doppler effect remains for all of them the same. [See Abstract 2669 (1925).] E. F.

628. Disruptive Discharge for Instantaneous Spectrograms. H. Nagaoka, D. Nukiyama and T. Futagami. *Imp. Acad. Tokyo, Proc.* 3. *pp.* 499–502, *Oct.*, 1927. *In English.*

The discharge previously used [see Abstract 98 (1928)] has been photographed, reproductions showing particles shot off and oxidised on their passage through the air. The state of vapour round the electrodes was investigated by a modified Schlieren method, and it is found that the sound waves travel at a speed a little in excess of the usual velocity of sound. Spectrograms show that many lines are emitted at different phases of electrical oscillation. F. S.

629. Spectral Filters for the Ultra-Violet. T. M. Dahm. *J.O.S.A. and R.S.I.* 15. *pp.* 266–284, *Nov.*, 1927.

Aqueous solutions of 32 organic compounds were examined by the extinction point method, using a geometrical series of concentrations, in a search for media having high gradation of absorption. Curves of log (concentration) against frequency are given. Certain advantages are claimed for the method when the gradation is large, and a modification of the method is suggested. F. S.

630. Fine-Structure and Electron-Terms of Band Spectra. E. Hulthén. *ZS. f. Phys.* 45. 5–6. *pp.* 331–336, 1927.

It is shown that in general the arrangement of fine-structure is in accordance with Hund's theory for band spectra of the type $^2P\rightarrow{}^2S$ and $^2S\rightarrow{}^2S$. A far-reaching parallel is found between the appearance of intercombinations in atomic and molecular spectra of the elements of the second group. F. S.

631. Infra-Red Absorption Spectra of Several Gases. C. F. Meyer, D. W. Bronk and A. A. Levin. *J.O.S.A. and R.S.I.* 15. *pp.* 257–265, *Nov.*, 1927.

The spectra of acetylene, ethylene, *n*-butane, *n*-hexane, *n*-octane, benzene, toluene, cumene, ethyl alcohol, ethyl ether, and sulphur dioxide were investigated with a grating of 1134 lines per cm. in the region between 3 and 4 μ. The absorption curves are represented in figures. A table gives the wave-numbers of the maxima and selected wave-number differences. The individual lines of the bands are not revealed, but the envelopes are obtained. From the latter an attempt is made to state what branches are present in the bands. Attention is called to relations existing among the wave-number differences. AUTHORS.

632. Molecular Spectra of Silver Iodide. J. Franck and H. Kuhn. *ZS. f. Phys.* 43. 3–4. pp. 164–171, 1927.

The absorption of silver iodide vapour has been investigated down to 2400 Å. and a continuous and a discontinuous spectrum found. It is concluded that the continuous spectrum corresponds to a dissociation into an excited iodine atom and a normal silver atom. The discontinuous spectrum is connected with resonance fluorescence. From both spectra it is concluded that the silver iodide molecule is not an ionic compound. A. C. M.

633. Secondary Spectrum of Hydrogen and other Spectra. H. Deslandres. *Comptes Rendus*, 185. *pp.* 905–909, *Nov.* 7, 1927.

The author's formula $\nu = qd_1/rs$, in which d_1 is a universal constant equal to 1062·5, is applied to the measurements of McLennan, Grayson-Smith and Lea of the intensities in the secondary spectrum of hydrogen, and it is concluded that the most probable molecule to be concerned is H_3. Similarly, it is suggested that the molecule active in the ultra-violet spectrum of water vapour is O_2 and that N_2 emits the vacuum spectrum of nitrogen in the extreme ultra-violet. F. S.

634. Electrodeless Ring Discharge in Hydrogen. The Spectra of Hydrogen. G. Herzberg. *Ann. d. Physik*, 84. 5. *pp.* 553–564, *and pp.* 565–604, *Nov.* 19, 1927.

In the first paper the appearances obtained with the electrodeless ring discharge in hydrogen are dealt with as follows: A brief account of earlier work on the subject, a description of the apparatus used, and a detailed account of the different discharge forms. The second paper deals entirely with the spectra of hydrogen obtained with the ring discharge. The Balmer spectrum under different discharge conditions is dealt with at length, then the following points are considered: Purity and extension of the Balmer series; the continuum limit of the Balmer series; intensities in the Balmer series; explanation as a light effect produced by re-union of protons and electrons; the continuous hydrogen spectrum; the many lined spectrum; the action of impurities. Useful lists are given of former papers, and the second paper is illustrated with a series of photographs of the spectra obtained. A. E. G.

635. Continuous Hydrogen Spectrum. Z. Bay and W. Steiner. *ZS. f. Phys.* 45. 5–6. *pp.* 337–342, 1927.

Two hydrogen discharge tubes are described which produce the continuous spectrum of great intensity under a sustained current of 500 mA, and which are suitable as light sources for absorption work in the ultra-violet. The dependence of the intensity of this spectrum upon pressure and current is investigated. F. S.

636. The Continuous Spectra of Hydrogen. G. Herzberg. *Phys. Zeits.* 28. *pp.* 727–728; *Disc.*, 728, *Nov.* 1, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

This paper summarises briefly investigations to be published in detail in the *Annalen der Physik*: (A) The continuous spectrum forming the boundary of the Balmer series (Grenzkontinuum). Using the electrodeless ring discharge in hydrogen, it has been found possible to obtain this spectrum in the laboratory, previous observations being astronomical. The intensity variation in the continuum is continuous with that in the series. (B) The general continuous spectrum of hydrogen. The hypotheses as to the origin of this spectrum are examined and the experimental conditions of excitation, etc., found to accord best with the view that the breaking up of molecular ions H_2^+ is the cause. W. S. S.

637. Structure of the Spectrum of OII. C. Mihul. *Comptes Rendus*, 185. *pp*. 937–939, *Nov*. 7, 1927.

The terms of the OII spectrum, which are derived from the normal electronic configuration of OIII, are divided into two systems, *a*, of quadruplets and doublets connected with the ^{3}P multiplet of OIII, a system *a′* of doublets connected with the ^{1}D multiplet OIII, and a system *a′* of doublets connected with the term ^{1}S of OIII. Combinations of the multiplet $a4p^4D$ with the term $a3d\,.\,^4F$ are tabulated, and also combinations with the terms $a'\,.\,3p\,.\,^2F$, $a'\,.\,3d\,.\,^2F$ and $a'\,.\,3d\,.\,^2G$.

F. S.

638. Absorption of Light in Dry Chlorine. G. Kornfeld and W. Steiner. *ZS. f. Phys*. 45. 5–6. *pp*. 325–330, 1927.

The authors determine the absorption spectrum in completely dry chlorine by means of a large Rowland concave grating and find that the converging positions of the bands, within limits of experimental error, have the same wave-lengths as for chlorine which has not been dried; accordingly the dissociation resulting by illumination with a definite wavelength is independent of the drying. As a criterion of the degree of drying the delay in formation of hydrochloric acid when illuminated with blue light is made use of; the quantitative yield by illumination with ultraviolet light is determined anew. The authors refer to the conclusions of Kahn based on a continuation of the considerations of Franck [see Abstract 1940 (1926)] on the dissociation of a chlorine molecule into an excited and non-excited chlorine atom moving independently of each other with indefinite kinetic energy. Several other photochemical reactions and theories are also considered. The authors describe their own experimental work in detail. J. K.

639. Spark Spectra of Chlorine. L. and E. Bloch. *Ann. de Physique*, 8. *pp*. 397–423, *Nov*., 1927.

The spectra were excited by an oscillating discharge in an electrodeless tube containing powdered salt. The spectra of ClII and ClIII have been separated, the lines of ClI being either absent or very faint in this method of excitation. A table of wave-lengths from 6850 Å. to 2200 Å. is given, in which comparison is made with the value of other observers.

F. S.

640. Spark Spectra of Chlorine and Bromine in the Schumann Region. G. Vaudet. *Comptes Rendus*, 185. *pp*. 1270–1272, *Dec*. 5, 1927.

The electrodeless discharge in powdered sodium salts was used in a tube provided with a fluorite window and the spectra photographed with a vacuum grating spectrograph. Tables of wave-lengths from 2250 Å. to 1300 Å. are given. F. S.

641. Spectra of Tin and their Zeeman Effects. J. B. Green and R. A. Loring. *Phys. Rev.* 30. *pp.* 574–591, *Nov.*, 1927.

Analysis of the spectra of Sn, SnI, SnII, SnIII.—(1) Zeeman effects of the lines of the tin spectrum have enabled the authors to classify the spectra of tin in the neutral state and in two stages of ionisation. (2) The spectrum of neutral tin has 5 low levels, ${}^3P_{012}$, ${}^1D'_2$, ${}^1S'_0$, due to the configuration $5_2 5_2$. The configuration $5_2 6_1$ yields ${}^3P'_{102}$ and ${}^1P'_1$. The configuration $5_2 5_3$ yields twelve terms of which the four lowest are definitely established. Pauli's *g*-sum rule is found to be valid. The ionisation potential of SnI is calculated as 7·37 ± 0·05 volts and the resonance potential 4·30 volts. (3) The spectrum of SnII is a doublet spectrum like InI, and the principal doublet separation found from some results of Lang is found to be 4253 cm.^{-1}. Several series are noted, including lines due to abnormal states, the electrons having the configuration $5_1 5_2 5_2$. The ionisation potential is computed as approximately 14·5 volts and the resonance potential 6·5 volts. (4) The spectrum of SnIII consists of singlets and triplets, like that of CdI. Several series are noted, and the ionisation potential calculated as about 30 volts and the resonance potential as 6·81 volts. A very strong group in the extreme ultra-violet is classified as a *pp′* group. (5) Application of the regular doublet law leads to possible classifications in the spectra of InII and GeII.

AUTHORS.

642. Zeeman Effect and Structure of the Arc Spectrum of Rhodium. L. A. Sommer. *ZS. f. Phys.* 45. 3–4. *pp.* 147–193, 1927.

A comprehensive study of the rhodium arc spectrum. The first step in the reduction of the spectrum to its series has been taken, as it has been shown from measurements of some 1600 lines in the spectrum of the rhodium arc which lines belong to neutral and which to ionised atoms. The region studied extended from 8600 Å. to 2300 Å. By means of intensity investigations and a study of Zeeman effects approximately 1000 lines have been arranged as combinations of 136 terms of the arc spectrum. An extrapolation to the series limit gives the ionisation potential as 7·7 volts. The Zeeman effects cannot be represented by the Landé *g* formulæ, but the observed group of terms follow the Russell-Pauli-Heisenberg-Hund scheme. The paper also contains tables of terms, photographs of abnormal Zeeman effects, a comparison of the theoretical and empirical term values, term and series limits, comparisons of the term systems of Ru, Rh and Pd, ionisation potentials of the elements of the iron and palladium groups, as well as tables of the classified lines.

W. V. M.

643. Series in the First Spark Spectrum of Tin (SnII). A. L. Narayan and K. R. Rao. *ZS. f. Phys.* 45. 5–6. *pp.* 350–363, 1927.

In two previous papers Rao has studied the spectra of doubly-ionised tin (SnIII) and of trebly-ionised tin (SnIV) [see Abstracts 2060 (1927) and 91 (1928)]. The authors have measured the spectrum of tin under a number of different experimental conditions, and find that many of the easily excited lines can be arranged in a doublet system, which strongly resembles those of CII, SiII and PbII, and agrees in all respects with the requirements of Hund's theory. The deepest term is identified as a $^2P_1$ term, with the term value 117,678·8 cm.$^{-1}$, and this makes the second ionisation potential of tin 14·53 volts. A number of new tin lines have been observed, the wave-lengths of which have been accurately measured with a concave grating. The nomenclature and numbering of the terms are essentially those of Landé. Tables give details of the different series which have been found, and the calculated and observed terms with the corresponding arrangements of the electrons, the term values and the effective quantum numbers. **H. N. A.**

644. Series of Emission and Absorption Bands in the Mercury Spectrum. (Lord) Rayleigh. *Roy. Soc., Proc.* **116.** *pp.* **702–719,** *Nov.* **1, 1927.**

Emission bands from λ3055 to λ2697 were described in a previous paper [see Abstract 2510 (1927)]. In searching for absorption bands in the same region, a tube giving the continuous spectrum of hydrogen was used as source, with absorption tubes varying from 45 to 178 cm. long; the pressure of the mercury vapour could be varied from about 3 atmospheres down to any fraction of 1 atmosphere. The bands are similar to the emission bands, but not identical with them. The absorption bands can be traced from about λ2943, spacing 146 cm.$^{-1}$, to λ2614, spacing 50 cm.$^{-1}$; there are no sharp heads. Some remarks are made on the theory of the two sets of bands in question, but no definite result is arrived at. The more refrangible group of absorption bands between λ2350 and λ2290 has also been investigated; in addition to the previously known bands a series of finer spacing has been found, in part superposed on the known ones; 48 have been observed and the convergence point found by extrapolation as λ2264; they are of the normal type, with heads, and are shaded to the red. The convergence point probably represents dissociation into a neutral atom and one excited to the 1^3P_2 state.

H. N. A.

645. Density of Vapour in the Mercury Arc and the Relative Intensities of the Radiated Spectral Lines, with Special Reference to the Forbidden Line 2270. B. Venkatesachar. *Roy. Soc., Proc.* **117.** *pp.* **11–29,** *Dec.* **1, 1927.**

The effect of altering the density of the vapour in a mercury arc on the relative and absolute intensities of the radiated lines has been studied within the approximate pressure-ranges of 2 mm. to 0·1 mm. of Hg. The current density employed ranged between 1·5 amperes cm.$^{-2}$ and 4 amperes cm.$^{-2}$. The effect of lowering the density of the vapour on the series lines in the arc spectrum is to increase the absolute intensities of all lines below $m = 5$ and diminish those of all lines above $m = 6$. It is pointed out that this result can be explained on the hypothesis that inelastic collisions between excited atoms in lower energy levels and thermally energetic normal atoms form the chief source of the radiators of the higher members of the series lines. To the radiators of the lower members the contribution from this source is negligible. This accounts for the intensity diminution of the higher members when the vapour density is diminished. On increasing the vapour density, collisions between the radiators of the lower members and normal atoms resulting in radiationless transitions increase and the intensities of these lines fall.

The forbidden line 2270 ($1^1S_0 - 2^3P_2$), like the lower members of other series lines, increases in intensity when the arc passes to the lower density stages.

In one set of measurements the line 4916 ($2^1P_1 - 3^1S_0$) showed the largest percentage increase of intensity on lowering the density of the vapour ($I_2/I_1 = 1{\cdot}40$). Next came lines 5769 ($2^1P_1 - 3^3D_2$) and 5790 ($2^1P_1 - 3^1D_2$) ($I_2/I_1 = 1{\cdot}30$). The lines 5461, 4358 and 4047 ($2^3P_{012} - 2^3S_1$) showed the smallest increase ($I_2/I_1 = 1{\cdot}15$) These results suggest that the dimensions of the orbits of the valence electron in the excited stages, 2^3S_1, 3^1D_2 (3^2D_2) and 3^1S_0, are in increasing order of magnitude. The spark lines excited in the mercury are classified. A. B. W.

646. Line Spectrum of Mercury in Absorption. Occurrence of the "Forbidden" Line λ2270 $1^1S_0 - 1^3P_2$. (Lord) Rayleigh. *Roy. Soc., Proc.* **117.** *pp.* **294–299,** *Dec.* **1, 1927.**

The forbidden line of mercury $1^1S_0 - 1^3P_0$ 2270 has now been observed as a sharp absorption line in the unexcited vapour [see Abstract 2510 (1927)]. The quantity of mercury required appears to be of the order 10^7 times as much as for the resonance line $1^1S_0 - 1^3P_1$, 2537. H. H. Ho.

647. Spark Spectrum of Mercury at High Frequencies. J. Rossignol. *Comptes Rendus*, **185.** *pp.* **1273–1274,** *Dec.* **5, 1927.**

The circuit was maintained in oscillation between frequencies $1{\cdot}2 \times 10^8$ and 7×10^4 by a three-electrode valve, and the spark produced between an amalgamated copper point and a drop of mercury. Photographs with a Féry spectrograph show that in general the arc spectrum is emitted, while lines of the first spark spectrum appear as the frequency diminishes. Bands due to nitrogen and water vapour appear with increasing strength as the frequency increases. F. S.

648. Spectrum of Carbon Arcs in Air at High Current Densities. J. W. Ryde. *Roy. Soc., Proc.* 117. *pp.* 164–182, *Dec.* 1, 1927.

The positive carbons were cored with metallic salts (rare earth fluorides) permitting the limiting current density of ordinary arcs to be exceeded. As the current is increased there appears in the arc stream a bright central core in which the spectra of C1, N1, O1, together with the Balmer series and the strongest lines of the red spectrum of argon, are excited. The relative intensities of the C1 and N1 lines are found to differ in many instances from those derived from discharge tube measurements. Over 50 new lines were found and ascribed to either N1, O1, or C1. The lines attributed to helium by Bell and Bassett are shown to be, in fact, prominent lines belonging to the spectra mentioned above. The Swan bands are strongly excited close to and inside the positive crater, but do not occur normally in the arc stream. A jet of hydrogen on the arc brings them up faintly and a jet of coal-gas very brightly. W. S. S.

649. Analysis of the Copper Spectrum. Part II. Complex Separations and Quartet Relations. W. M. Hicks. *Phil. Mag.* 4. *pp.* 1161–1227, *Nov.*, 1927. *Supplement.*

The paper is a sequel to previous work [see Abstract 2609 (1926)], and begins with a short discussion of the inverse D lines, the result of which is to indicate the possibility that these and 5105, with the separation 2042, may not belong to doublet systems. Evidence is given for the existence of quarter systems depending on *d* terms with separation 2042, 1412, 894, and with separations completely following Landé's separation rules. Several other quartet examples are given, and Shenston's lists of fundamental lines with 2042 separations are then discussed. An attempt is made to allocate them on the basis of the maps of [I]. The quarter arrangements given by Beals, adopted later by Shenstone and by Sommer, are then specially considered and certain difficulties connected with the two-term theory of line constitution discussed. The evidence from the Zeeman effect appears on the whole to contradict the allocations suggested by them, but the conclusion is drawn that Landé's rules for Zeeman patterns do not apply to these systems. The majority of their quartet separations appear also to be composite, and the quartets involved are not real ones. W. V. M.

650. Related Lines in the Spectra of the Elements of the Iron Group. H. N. Russell. *Mt. Wilson Observat., Contrib. No.* 341. *Astrophys. J.* 66. *pp.* 184–216, *Oct.,* 1927.

Recent theories of spectral structure suffice to identify those groups of homologous lines in the spectra of different elements which arise from similar electronic transitions within the atoms. Such groups have quite different spectroscopic names and multiplicities, but show very similar physical and astrophysical behaviour. Tables are given of the homologous terms in the arc spectra from K to Zn and in the spark spectra from Ca^+ to Zn^+. The identifications of the lower terms follow Hund; those of many of the higher terms are new. The relations of the terms are illustrated graphically, thus clearing up certain doubtful questions. Tables are also given of the homologous lines which arise from eight different electronic transitions in the neutral, and four in the ionised atom. The transition from a *4p* to a *4s* orbit accounts for most of the strongest lines in both the arc and the spark spectra. These lines shift steadily towards the ultra-violet as the atomic number increases. Transitions from a *5s* to a *4p* orbit give arc lines in the visible region, some of which are strong, while others make it possible to determine the ionisation potential. Many other sets of homologous lines may be identified when the spectra have been more completely analysed. If the elements of the iron group are written as follows,

K	Ca	Sc	Ti	V	Cr	Mn
Zn	Cu	Ni	Co	Fe	Mn	Cr

the spectrum of any element contains a large portion which is very similar to a corresponding portion of the element above or below, and one step to the right, and another portion similarly related to a part of that of the element above or below and to the left. Each spectrum also contains other portions peculiar to itself. AUTHOR.

651. Automatic Cloud Chamber for the Rapid Production of α-Ray Photographs. P. M. S. Blackett. *Journ. Sci. Instruments,* 4. *pp.* 433–439, *Nov.,* 1927.

An automatic cloud chamber apparatus is described for taking large numbers of α-ray photographs as rapidly as possible. The conditions for producing good tracks, and the cycle of operations required to realise these conditions, are discussed. An outline of the general design of the apparatus in its final form is given, followed by a detailed description of the chamber itself and of the source and α-ray shutter. AUTHOR.

652. Fluorescence in Mixtures of Ammonia and Mercury Vapour. A. C. G. Mitchell. *Am. Chem. Soc., J.* 49. *pp.* 2699–2703, *Nov.*, 1927.

Reference is made to an earlier work [see Abstract 1567 (1927)] wherein a greenish fluorescence was examined. In the present paper the ultraviolet fluorescence is investigated. It is suggested that excited ammonia molecules are responsible for both emission and decomposition. J. K.

653. Comparison of X-Ray Interference Patterns of Organic Substances in the Solid and Liquid States. R. O. Herzog and W. Jancke. *ZS. f. Phys.* 45. 3–4. *pp.* 194–199, 1927.

A study of some 25 organic substances leads to the enunciation of the following rules: (1) A strong amorphous ring lies in the neighbourhood of one or more particularly strong crystalline interference fringes; (2) if the amorphous rings be near the central direct beam they are shifted outwards with respect to the crystalline interferences, but if they lie nearer the periphery they are shifted inwards with respect to the crystalline diffraction. **Errata,** *ibid.* 45. 9–10. *p.* 749, 1927. W. V. M.

654. Quality and Quantity of Scattered X-Radiation from Water. F. Vierheller. *Phys. Zeits.* 28. *pp.* 745–757, *Nov.* 15, 1927.

A method has been developed to measure the X-radiation scattered from a layer of water, the nature of the scattered radiation being expressed in terms of its mean wave-length. Calculation and observation are shown to be in good agreement. A. B. W.

655. Measurement of X-Rays by the Ionisation Method in Absolute "R" Units. H. Küstner. *Phys. Zeits.* 28. *pp.* 797–803, *Nov.* 15, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

The Röntgengesellshaft and the Reichsanstalt have adopted the name of "Röntgen" for the absolute unit of X-ray dose as defined by them. This definition requires the measurement of the quantity of electricity carried by the saturation current, using the ionisation method, in electrostatic units. For practical measurements it is impossible to carry out absolute determinations constantly, and the author has devised an apparatus by means of which measurements can be carried out by comparing the ionisation produced by the X-rays with that produced by a constant radium preparation introduced into the ionisation chamber. The apparatus may be calibrated empirically by comparison with one in which absolute measurements are carried out, or these measurements may be made with the apparatus itself with the help of a Harms condenser. Corrections are required, when the hardness of the X-rays is altered, for barometric height, temperature, etc. Once calibrated the apparatus can be transported by rail or road, and gives accurate results after the journey without recalibration. H. N. A.

656. Structure of the $K\alpha$-Lines of the Elements Cu to Ca. N. Seljakow, A. Krasnikow and T. Stellezky. *ZS. f. Phys.* 45. 7–8. *pp.* 548–556, 1927.

A method is described whereby the resolving power of a Siegbahn vacuum spectrograph may be considerably increased. A peculiarity (fading on one side) of the $K\alpha$-lines of the elements Ni to Ti is discussed.

The existence of two types of normal Röntgen spectra appears probable. In the first each spectral line is simple, in the second multiple. The first is characteristic of the elements Cu, Zn, etc., the second of elements with an imperfect inner electron shell, *e.g.*, Fe, Mn, etc. In the explanation of these phenomena the authors consider that a relativistic interpretation of the $K\beta'$ and $K\beta_1$ lines must be discarded. Somewhat improbable also is the assumption of Wentzel, upheld later by Ortner, that an incomplete M-electron shell can bind a superfluous electron. The negative results of the experiments of Coster and of Seljakow and Krasnikow, who tried to find absorption lines identical in wave-length with the line $K\beta'$, contradict the assumption that $K\beta'$ is a line of the spark spectrum. Only a special hypothesis could explain why an electron emitted from the K shell is not bound by those elements having incomplete inner groups of electrons. Coster and Druyvesteyn [see Abstract 1429 (1927)] suggest a better explanation. They assume that in the case of elements with incomplete inner electron shells the normal spectra are multiplets, whereas with the other elements they are known to be doublets. The paper contains numerous curves and an illustration of the apparatus employed. [See also Abstract 2078 (1927).] E. F.

657. L X-Ray Absorption Edges of Sn (50), In (49), Cd (48), Ag (47), Pd (46), Rh (45) and Ru (44). G. D. van Dyke and G. A. Lindsay. *Phys. Rev.* 30. *pp.* 562–566, *Nov.*, 1927.

The L X-ray absorption edges of the elements Sn (50), In (49), Cd (48), Ag (47), Pd (46), Rh (45) and Ru (44) have been photographed and measured with a Siegbahn vacuum spectrograph of the precision type. The absorbing screens were made of the pure elements, since in this case the values of the energy levels obtained are admittedly more characteristic of the element than if chemical compounds were used as absorbers. Tables of wave-lengths of absorption edges and associated energy levels are given. AUTHORS.

658. Law of Absorption of X-Rays by Matter. P. Villard. *Comptes Rendus*, 185. *pp.* 1415–1419, *Dec.* 19, 1927.

The author advances theoretical reasons involving atomic resonance which bear on the laws of absorption of X-rays scattering and pure absorption (fluorescence), and quotes a series of results obtained by Allen [see Abstract 1591 (1926)] to support his conclusions. A. B. W.

659. X-Ray Spectra of Long Wave-Length. T. H. Osgood. *Phys. Rev.* 30. *pp.* 567–573, *Nov.*, 1927.

The paper describes a photographic method of obtaining X-ray spectra of long wave-length, based on the experimental fact that X-rays are totally reflected from a mirror (or grating) provided the angle of incidence is sufficiently large. Details are given of a vacuum spectrograph employing an X-ray tube as a source of radiation, in conjunction with a two-metre concave grating. About fifteen lines have been measured between 40 and 200 Å. As it has not yet been possible to obtain a pure spectrum of any one element, the interpretation of these lines is a matter of considerable uncertainty. Nearly half of them appear to be due to strontium and barium deposited on the antikathode from the oxide coated filament of the X-ray tube. The method is applicable to all wave-lengths greater than about 20 Å. AUTHOR.

660. Spectrograph for X-Rays of Great Wave-Length. J. Thibaud. *J. de Physique et le Radium*, 8. *pp.* 447–450, *Nov.*, 1927.

Description of a new type of vacuum spectrograph using a ruled grating and tangential incidence of radiation. The theory was developed in a previous paper [see Abstract 2930 (1927)]. The source of radiation is here, not a condensed spark as in the previous experiments, but a metal X-ray tube with hot kathode and water-cooled interchangeable target run at 1000 volts. The spectra are registered on ordinary photographic plates which have been oiled. The plane gratings used are of two types, the first having 200 lines per mm. and a second 1180 per mm. The spectra obtained under these low voltages are purely X-ray spectra showing no ultra-violet or continuous background. The wave-lengths of several radiations have been determined absolutely. Lα iron = 17·7 Å., Kα oxygen = 238 Å., Kα carbon = 44·9 Å., M molybdenum = 65·0 Å. The method employed establishes contact between X-rays and the ultra-violet.

W. V. M.

661. Input Limit of an X-Ray Tube with Circular Focus. A. Müller. *Roy. Soc., Proc.* 117. *pp.* 30–42, *Dec.* 1, 1927.

The input limit of an X-ray tube depends on various factors, one of which is the heat produced on the antikathode by the impinging kathode rays. The present paper deals with an attempt to calculate the input limit for an X-ray tube with circular focus. The author's deductions are shown to be in reasonable agreement with the performance of typical X-ray tubes.

A. B. W.

662. Röntgenographic Investigation of Passive Metals. F. Krüger and E. Nähring. *Ann. d. Physik*, 84. 7. *pp.* 939–948, *Dec.* 23, 1927.

The results are given of the X-ray examination of finely powdered passive iron, nickel and chromium by the Debye-Scherrer and Bohlin-Seeman methods. In no case does the photograph show lines corresponding with a known or unknown oxide of the metal, although these should be apparent if an oxide layer 10^{-7} cm. in thickness were present. These results are not in agreement with the view that solid layers of oxide are present on these metals in the passive state. The existence of a molecular layer of oxygen which Tammann suggests may cause passivity—the free valencies of the metal at its surface being saturated by oxygen atoms, while the metal-lattice remains unchanged—would not be detectable by X-ray examination.

T. H. P.

RADIOACTIVITY.

663. Most Recent Investigations of Atomic Disintegration. G. Stetter. *Phys. Zeits.* 28. *pp.* 712–723, *Nov.* 1, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

A review of the work of the last few years, which has been carried out in order to explain the discrepancies in the results obtained in Cambridge and in Vienna. Several of the papers reviewed are concerned with the details of the scintillation method; and other methods such as the Wilson cloud method, the ionisation method, the photographic method and the use of the mass spectroscope are dealt with. Attention is called to the large number of H-particles which are given off according to the

Vienna school. If this is not confined to a small angle, but holds for all directions in space, it seems that the total amount of disintegration must in certain cases be sufficient to enable spectroscopic evidence of the existence of the products of disintegration to be obtained. Experiments in this direction are being carried out in Vienna. H. N. A.

664. Average Energy of Disintegration of RaE. C. D. Ellis and W. A. Wooster. *Roy. Soc., Proc.* 117. *pp.* 109–123, *Dec.* 1, 1927.

The experiments described in this paper show that the average energy of disintegration of RaE is about 350,000 volts, and this energy is liberated in such a form that the major portion, 344,000 volts, is stopped by 1·2 mm. of lead and the remainder has an absorption coefficient in lead of 5·9 cm.^{-1}. The interpretation of this result is as follows. The main energy is due to the disintegration electrons, and the small extra radiation is probably continuous γ-radiation of a relatively hard type, emitted by a few of the disintegrated electrons which suffer close collisions with the planetary electrons in their escape from the atom. These results have been confirmed by independent methods. The authors generalise the results obtained for RaE to all β-ray bodies, thereby settling a long controversy. We must conclude that in a β-ray disintegration the nucleus can break up with emission of an amount of energy that varies within wide limits. A simple hypothesis is put forward to explain this curious result. A. B. W.

665. Ionisation and Stopping Power of Various Gases for α-Particles from Polonium. Part I. G. E. Gibson and E. W. Gardiner. *Phys. Rev.* 30. *pp.* 543–552, *Nov.*, 1927.

Determinations of the differential ionisations and stopping powers of hydrogen, neon, nitrogen, oxygen, argon, and methyl iodide have been made at intervals along the range of α-particles from polonium. From the results of these and other determinations it is shown that the energy lost by the α-particle per ion is nearly independent of the speed throughout the range. There are slight but definite systematic deviations from constancy for oxygen and methyl iodide. AUTHORS.

666. Ionisation and Stopping Power of Various Gases for α-Particles from Polonium. Part II. G. E. Gibson and H. Eyring. *Phys. Rev.* 30. *pp.* 553–561, *Nov.*, 1927.

The ionisations of nitric oxide, nitrous oxide, and air were found to be strictly proportional along the range, while methyl iodide shows definite systematic deviations. A method of determining differential stopping powers for α-particles has been applied to a number of gases. The results show that such unstable molecules as NO and $H_3C-N=NCH_3$ give strictly additive stopping powers. The stopping powers of all investigated gases are constant within 1 or 2 % for the first 16 mm. of range for α-particles from polonium. The method used by Gurney, and by Gibson and Gardiner, for determining stopping powers at the end of the range was investigated, and modified in some details. A series of stopping powers for each of four gases was obtained. The portion of a Bragg ionisation curve between the maximum and the last 1·5 mm. is approximately a straight line. If the ionisation curve for an individual α-particle is a straight line, and if the straggling of the α-particles is given by the equation $y = e^{(-s/a)^2}/\pi^{1/2}a$ (derived theoretically by Bohr and Flamm, and tested experimentally by Irène Curie, Briggs, and others), the end of the Bragg ionisation curve is accurately reproduced. This has been shown by Henderson and by Irène Curie. The values of α which they used were obtained from other considerations. The inverse process, that of finding α from the end of the Bragg ionisation curve, has been shown in this paper to give values of α for air which agree with those given by the other methods. This procedure is applicable to the study of straggling in any substance chemically non-reactive. AUTHORS.

667. Half-Period of Radium E. L. F. Curtiss. *Phys. Rev.* 30. *pp.* 539–542, *Nov.*, 1927.

The earlier measurements of the decay of RaE [see Abstract 2125 (1926)] have been extended to four additional preparations. One of these proved to be practically pure RaE. One apparently was contaminated by about 2 % RaD, and the figure (4·965 days) for it has been discarded. The half-periods for the other three are: 4·978 days, 4·978 days, and 4·971 days, with a mean of 4·975 days. AUTHOR.

668. Accurate Measurement of Ra-Emanation. J. v. Weszelsky. *Phys. Zeits.* 28. *pp.* 757–761, *Nov.* 15, 1927.

A new form of apparatus is described for the accurate estimation of radium emanation. As a test of its accuracy the emanation from a radium standard solution containing $15{\cdot}70 \times 10^{-6}$ mg. (by γ-ray measurement) was determined on different occasions with the following results: (1) $15{\cdot}84 \times 10^{-6}$ mg., and (2) $15{\cdot}82 \times 10^{-6} \pm 0{\cdot}5$ %. The original paper should be consulted for details of the method. A. B. W.

669. Retarding Powers per Atom of the Elements for α-Rays. S. Rosenblum. *Comptes Rendus*, 185. *pp*, 1275–1277, *Dec.* 5, 1927.

In a previous paper the author has given a formula connecting the superficial density X of a screen with a constant K depending on the material and with the percentage diminution of the velocity of the X-rays passing through it. By means of this he now defines the retarding power of an element per atom, and compares this with Bragg's stopping power deduced from the ionisation curve. Since the author's formula is not strictly correct for large retardations, some difference between the retarding powers and the stopping powers is to be expected. A table gives values of the stopping power of a number of elements determined by other observers, and of the retarding powers determined by the author. Different formulæ have been proposed to show the relation between the stopping power and the atomic number N, or the atomic weight A, and the values of some of these are tabulated and also the values derived from the author's new expression $0{\cdot}43\mathrm{N}/\sqrt{\mathrm{N}+4}$. This agrees with the experiments better than the others. It is also shown that the absorption of energy per electron diminishes when N increases, which agrees with Bohr's theory. H. N. A.

670. Resolution of Wilson's α-Ray Tracks into Single Water Drops. O. Klemperer. *ZS. f. Phys.* 45. 3–4. *pp.* 225–230, 1927.

Shows how, using low pressure hydrogen in the expansion chamber, the number of separate drops can be so reduced, and the distance between them increased, that they can be observed separated in a microscope and photographed. It is possible to draw conclusions as to the ratio between the ions produced directly by the α-ray and the secondary ions produced by the electrons ejected; it appears that there are about two secondary ions to one direct one. Most of the secondary electrons are so slow that they can at most ionise only two molecules, but higher velocities are also represented, including the so-called δ-rays. About 50 volts of energy are given up by the α-particle in the formation of each of the pairs of ions, direct and secondary. H. N. A.

671. Spectra of Scintillations. W. Kutzner. *ZS. f. Phys.* 45. 5–6. *pp.* 343–349, 1927.

The colours of the light given out by different specimens of zinc sulphide, to which small quantities of Cu, Bi or Ur have been added, have been studied when they were excited by light, by α-rays and by friction (triboluminescence); the spectra due to phosphorescence and to scintillations were photographed and compared; considerable differences were found; exposures of from two to twenty-five days were required. It was not possible to photograph the spectrum due to triboluminescence. It does not appear that the α-ray scintillations can be ascribed to triboluminescence as the colours of the light are in all cases different for the two phenomena. The author does not think that the bands in the scintillation spectra are identical with those in the phosphorescence spectra.
H. N. A.

672. Relation between the Scintillations and the Structure of Zinc Sulphide. The Cause of the Scintillation Process. Berta Karlik. *Akad. Wiss. Wien, Ber.* 136. 2*a*. *No.* 7. *pp.* 531–561, 1927.

Describes a photometric method by means of which the relation between the residual range of the α-particles and the brightness of the scintillations can be determined for differently prepared zinc sulphide copper phosphores. The influence of size of grain has been studied, and curves obtained showing the relation between the residual range and the brightness for a number of different specimens. It is shown that the form of the curves can be explained by assuming that the brightness of the scintillations is proportional to the total number of ions produced in the passage of the α-particle through the zinc sulphide crystal. This confirms the view that a scintillation depends on an action on the Lenard centres in the phosphore, which in each element of the path is proportional to the ionisation produced. The effect of optical absorption and reflection in the crystal was studied and found to be small. The differences of brightness of the scintillations in the same preparation were studied.
H. N. A.

673. Mobility of the Actinium A Recoil Atom Measured by the Cloud Method. P. I. Dee. *Roy. Soc., Proc.* 116. *pp.* 664–682, *Nov.* 1, 1927.

A field was employed, vertically downwards through the expansion space, and was so adjusted that the positive and negative ions in the track of an α-particle sent out by a disintegrating atom of actinium A were separated, so as to show two parallel straight lines. Nothing is visible in the photographs which records the life of the actinium A atom, but when this disintegrates, forming actinium B, an α-article is shot out, the track of which is in general inclined to the original track; this may also be doubled by the action of the field, giving two parallel straight lines. Photographs of four main types of grouped tracks were obtained, and the relative positions of their origins gave the mobility, and in some cases the life, of the A atom; the mobility found was 1·56 cm./sec./volt/cm. agreeing with the accepted value. There was direct evidence that some of the recoil atoms were uncharged at the end of their recoil track, the percentage of these agrees with Briggs's value. The lives were deduced for 47 cases, and the rough statistics are satisfactory. H. N. A.

674. Transmutation of the Elements by Kathode Rays. A. Koenig. *Phys. Zeits.* 28. *pp.* 838–841, *Dec.* 1, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

Jorissen and Ringer [see Abstract 1840 (1907)] and K. A. Hofmann observed an apparent increase in the activity of radioactive elements, when bombarded with kathode rays; that was probably due to surface increase of the preparations. Fajans could not confirm any such influence in 1919. The author and F. v. Körösy bombard lead first with kathode rays of half the velocity of light using an antikathode of copper in the shape of a cup; they then cut off the current, admit air into the tube and draw the air through charcoal into a chamber in which the cup is placed over the electroscope; these manipulations do not require more than a minute. There was no indication of the formation of any element giving β-rays of a half-period ranging from 1300 years to 33 seconds, or α-rays ranging from ·5 million years to 2 seconds. **G. Stetter** remarked that H. Müller had also had negative results in bombarding heavy elements with α-rays. H. B.

675. Radio Elements as Indicators. F. Paneth. *Nature*, 120. *pp.* 884–886, *Dec.* 17, 1927. *Paper read before the Bedson Club, Newcastle-upon-Tyne, March*, 1927.

A brief summary of the author's researches on the use of radio elements as indicators in chemical investigations with the common elements. The author rightly anticipates that the method will become more commonly used the more familiar the advantages of the method become to non-radiologists. The method is based on the isotopic behaviour of certain radioactive bodies with the ordinary elements. Thus ThC is *chemically inseparable* from bismuth and consequently, once added to bismuth, it always sticks to bismuth through all possible chemical reactions. Now ThC is easily detected and measured by means of ordinary ionisation apparatus (electroscopes, etc.), and it may therefore be used to indicate the presence, or otherwise, of bismuth in a particular preparation. Other valuable methods of using the isotopic property are outlined in the paper, and a table is given showing the various radioactive indicators and their common isotopic elements. An application of ThC-bismuth is suggested in therapeutics—to measure the proportion of bismuth stored in the body, etc. The applications are very numerous. A. B. W.

HEAT.

676. Thermal Expansion of Beryllium and Aluminium-Beryllium Alloys. P. Hidnert and W. T. Sweeney. *Bureau of Standards, Sci. Papers, No.* 565. *pp.* 533–545, 1927.

The results are given of the linear thermal expansion of beryllium (98·9 %) and five aluminium-beryllium alloys containing various percentages of beryllium (4 to 33 %). Expansion determinations were made over various temperature ranges, between − 120° and + 700° C. on a sample of beryllium, and between room-temperature and 500° C. on the aluminium-beryllium alloys. The expansion curves of beryllium and aluminium-beryllium alloys are shown and discussed. The average coefficient of expansion of beryllium is $12 \cdot 3 \times 10^{-6}$ per ° C. between 20° and 100° C. Beryllium expands considerably less than the other elements of subgroup IIB (magnesium, zinc, cadmium and mercury). The coefficients of expansion of the aluminium-beryllium alloys decrease with increase in the beryllium content. On a second heating the coefficients are generally larger than the corresponding values obtained in the first heating. The relations between the coefficients of expansion and the chemical composition are compared with the equilibrium diagram obtained by Oesterheld, and are found to be in agreement with theory. A table in the summary gives a *résumé* of the average coefficients of expansion derived from the data on all the samples for various temperature ranges between 20° and 500° C. AUTHORS.

677. Decrease in Volume of Metals and Alloys. F. Sauerwald, E. Nowak and H. Juretzek. *ZS. f. Phys.* 45. 9–10. *pp.* 650–662, 1927.

The authors define " Schwindung " as the percentage difference in the linear dimensions of a metallic body during solidification from the molten state from the dimensions after cooling down to ordinary temperature. The paper first discusses the question of the relation between the purely thermal length expansion and the results of technical practice. In particular an eventual initial elongation at the melting point of metals and alloys is examined. A method is outlined for the measurement of the elongation first mentioned above, avoiding the disturbing influences of other agencies, and the purely thermal decrease of dimensions then approximates very closely to the ideal case. The effects are related to the internal structural alterations as shown in the structure diagram. The experimental work covers a large range of metals and alloys. Full experimental details and results are given. S. G. B.

678. New Additive Property of Liquids. I. N. Longinescu. *Comptes Rendus,* 185. *pp.* 1472–1474, *Dec.* 19, 1927.

The internal pressure of liquids is expressed in the van der Waal equation by a/V^2, and van Laar has interpreted the constant a as equivalent to cm^2, where m is the attractive mass. It follows that $a^{\frac{1}{2}}$ is an additive property from which may be deduced that $a = cm^2V^{\frac{2}{3}}$. The present author suggests that $a_c^{\frac{1}{2}}V_c^{\frac{2}{3}} = \text{constant} \,.\, T_c^{\frac{1}{2}}V_c^{\frac{2}{3}} = c_1 + c_2 + \ldots$

is more accurate as an additive property than $a^{\frac{1}{2}}$, where $c_1, c_2 \ldots$ are characteristic constants for each different atom. This formula has been verified for the majority of liquids of known critical volume, and even for associated liquids. It thus appears as if a relation exists between molecular association and increase of attractive mass. Walden's formula, $T/\sqrt{M}=37$, may similarly be generalised to $T_c/\sqrt{M}=[c_1+c_2+\ldots]^2/V_c^{\frac{4}{3}}M^{\frac{1}{2}}$, *i.e.* the critical temperature of a compound may be calculated when the critical data of its components are known. H. H. Ho.

679. The Warming of Walls. A. F. Dufton. *Phil. Mag.* 4. *pp.* 888–889, *Nov.*, 1927.

In this paper the influence of the fabric of a wall is shown by the time taken to warm the surface when heat is supplied to it at a constant rate. For a 9-in. brick wall where the time is 6 hours, a 1-in. wooden wall affording the same insulation requires 10 minutes. The warming of a laminated wall depends largely upon the material at the heated surface. A room with masonry walls is much more readily warmed if lined with wood or other insulation of small thermal capacity. H. H. Ho.

680. The Exchange of Heat by Circulation of a Viscous Fluid in Tranquil Motion through a Cylindrical Tube. A. Lévèque. *Comptes Rendus*, 185. *pp.* 1190–1192, *Nov.* 28, 1927.

The velocity v follows Poiseuille's law, and in a cylindrical tube of radius R, $v = V(1-y^2/R^2) = -[(R^2-y^2)/4\eta]dp/dx$, where η = coefficient of viscosity, p = pressure. The heat equation is $V(1-y^2/R^2)\partial t/\partial x = a^2[\partial^2 t/\partial y^2 + (1/y)(\partial t/\partial y)]$, where $a^2 = K/c\rho$. Here K = thermal conductivity, c = specific heat, and ρ = density. The author takes t_m, the mean temperature, to be the product vt divided by the mean speed V/2. The true coefficient of convection is then $\alpha_x = Q(t_m - t_0)$, and the mean value for the length x is $\alpha_0^x = \left[\int_0^x Q \,.\, dx\right] \Big/ \int_0^x (t_m - t_0)x$, where Q = heat exchanged per unit of time and of surface, t_0 = wall temperature of tube. These coefficients are functions of a variable λ, where $\lambda = (R/a)\sqrt{V/x}$. When $\lambda < 1$, then approximately $\alpha_x = 3{\cdot}658K/2R$, and $\alpha_2'^x = 4{\cdot}36K/2R$. When λ is greater the coefficients also increase; the asymptotic value is therefore taken (λ great). The problem is taken of a plate with rectilinear edge in a fluid current whose velocity is parallel to the plate and perpendicular to its edge. This velocity is not uniform as in the case treated by Boussinesq, but varies proportionally to the distance from the plate. With t_0 constant it is found that $\alpha_x = (1/I^3)\sqrt[3]{(K^2 c\rho\beta)/(ax)}$, and $\alpha_0'^x = \sqrt[3]{(3K\lambda^{2/3})/(4I^3R)}$, the formula being applicable to a cylindrical tube when λ is sufficiently great. The exchange of heat is thus proportional to the cube root of the velocity. T. B.

681. The "Heat Plummet," an Instrument for the Registration of Depth Temperatures in Still Water. W. Schmidt. *Akad. Wiss. Wien, Ber.* 136. 2*a*. *No.* 7. *pp.* 481–486, 1927.

A description of an instrument for the self-recording of deep-sea temperatures, obviating the necessity for a number of thermometers at different depths. The instrument records both depth and actual temperature on a graph with 90° coordinates. The temperature record is derived from a bimetallic strip whose curvature works a lever arm. A diagram and full details are given. S. G. B.

682. Mechanical Equivalent of Heat. T. H. Laby and E. O. Hercus. *Roy. Soc., Phil. Trans.* 227. *pp.* 63–92, *Nov.* 2, 1927.

A description of precision experiments made for the determination of the value of the mechanical equivalent of heat. Full details are given of a new method of continuous flow calorimetry. An induction dynamometer similar to the squirrel-cage induction motor was used. A copper calorimeter is rotated in a rotating magnetic field, and thus a couple is caused to act on and to heat the calorimeter or stator. A rotating electromagnet produces the magnetic field. The input of energy is measured as being proportional to the mean couple acting on the calorimeter and to the number of turns on the rotor. These factors were measured with great precision. The water flows through the copper tubes of the stator and the heat is continuously absorbed. The heat developed is given by the mass of the water transmitted through the instrument and the rise of temperature, which has to be corrected for heat losses and friction of the water. A simple expression is evolved for J, namely, $J = \pi n \,.\, m \,.\, g \,.\, d_\theta f[W\{(\theta_2 - \theta_1) - v\} + L]^{-1}$, where $\pi n \,.\, m \,.\, g \,.\, d_\theta f =$ work done during experiment; $W\{(\theta_2 - \theta_1) - v\} =$ heat abstracted by the water; $L =$ heat lost during experiment; $v =$ increase of temperature due to the viscosity of the water. A full description of the experimental methods and precautions is given, and finally it is stated that as the mean of the experiments 1 calorie at 16·7° C. = 4·1841 × 10^7 ergs, with a probable error of ± 0·0001 × 10^7. Using Callendar's values for the specific heat variation of water, 1 calorie at 15° = 4·1860 × 10^7 ergs, 1 calorie at 20° = 4·1809 × 10^7 ergs on a scale of temperature of a Pt thermometer whose constants are determined at 0°, 100°, 444·55° on the thermodynamic scale. The value now obtained agrees with values found by indirect electrical experiments and confirms the present accepted absolute values of the practical electrical units. S. G. B.

683. Effect of Variable Specific Heats upon the Velocity Generated and upon the Temperature Drop in Gases Expanding through Nozzles. E. C. Wadlow. *Phil. Mag.* 4. *pp.* 917–922, *Nov.*, 1927.

Equations for calculating the velocity generated and the weight of gas discharged when a gas, initially at a high pressure, is allowed to expand through a nozzle to a lower pressure, taking into consideration the increase of specific heat with temperature, have been given by Walker [see Abstract 1482 (1922)]. The present paper supplements Walker's equations by giving formulæ for the calculation of the temperature of the gas at the end of an adiabatic expansion, thus providing an alternative method of calculating the theoretical velocity generated. The equations are applicable to the design of internal combustion engines.

A. W.

684. Latent Heat of Fusion and the Heat of Transformation of Some Metals. S. Umino. *Tohoku Univ., Sci. Reports,* 16. *pp.* 775–798, *Oct.*, 1927. *In English.*

The heat contents of manganese, thallium, carbon steels containing

0·57 % C, 0·94 % C, 1·16 % C, and of pig iron containing 4·31 % C and 1·11 % Si have been measured at high temperatures by the differential calorimetric method. From these results both the mean and the true specific heats have been deduced, and the mean value of the heat of the A_0 transformation in cementite has been found to be 9·72 calories. The heats of two transformations in manganese and that of thallium have been found to be 2·88, 4·53 and 0·60 calories respectively. The latent heat of fusion of manganese, thallium and pig iron have been found to be 64·8, 3·67 and 46·63 calories respectively. [See also Abstract 1066 (1927).] AUTHOR.

685. Freezing Points of Concentrated Solutions. Part III. Solutions of Phenol. E. R. Jones and C. R. Bury. *Phil. Mag.* 4. *pp.* 1125–1127, *Nov.*, 1927. *Supplement.*

This is a continuation of previous work [see Abstract 393 (1928)] on the activity of associated substances in aqueous solution. In this paper are recorded the freezing points and activities of solutions of phenol, which is the only common member of its class sufficiently soluble to be suitable for this work. A. E. G.

686. Molecular Dimensions of Ethylene. E. Mathias, C. A. Crommelin and H. G. Watts. *Comptes Rendus*, 185. *pp.* 1240–1242, *Dec.* 5, 1927.

The densities of liquid ethylene and of the saturated vapour are given from − 145° C. to 8° C. The observed values of the diameter are tabulated together with those obtained by the method of least squares as a linear function of the temperature. The differences are small but systematic, the curve being slightly concave towards the axis of temperature near the critical point and slightly convex at lower temperatures. A. Wh.

687. The Two Different Liquid States of Helium. W. H. Keesom and M. Wolfke. *Comptes Rendus*, 185. *pp.* 1465–1467, *Dec.* 19, 1927.

During a series of measurements of the dielectric constant of liquid helium it was observed that on lowering the temperature the constant abruptly changed at a given point which coincided sensibly with that of the maximum density found by Onnes. It was concluded that two different liquid states of helium exist, I and II, which have a transition point where the saturated vapour pressure is about 38 mm. of mercury. The helium state II, stable at the lower temperature, possesses the lower density, the greater heat of vaporisation and the smaller surface tension. Transformation from helium II into I is accompanied by absorption of heat, the temperature being approximately 2·3° K. It is noteworthy that the reduced temperature of the triple point I, II and vapour is of the same order of magnitude as that of the triple point solid-liquid-vapour of the majority of other bodies. **Errata,** *ibid.* 186. *p.* 331, *Jan.* 30, 1928. H. H. Ho.

688. Explosions in Gaseous Mixtures of Acetylene, of Hydrogen and of Pentane. A. Egerton and S. F. Gates. *Roy. Soc., Proc.* 116. *pp.* 516–529, *Nov.* 1, 1927.

By a procedure now described, measurement of the velocities of detonation waves by the photographic method previously employed [see Abstracts 1810, 1811 (1927)] can be made with an accuracy of at least 0·5 %. Results are given for the detonation velocities of mixtures of acetylene-oxygen, hydrogen-oxygen, and pentane-oxygen mixtures with oxygen, nitrogen or argon, at various initial pressures. Confirmation is obtained of the observation that detonation occurs earlier as the initial pressure is increased. The length of the tube used does not appreciably affect the position of detonation except when the latter is about to take place near the end of the tube, presumably owing to local increase of pressure; an exception to this general rule is furnished by the weak acetylene mixture ($C_2H_2 : 2{\cdot}5O_2 : 6N_2$), with which shortening of the tube is accompanied by retardation of the detonation. The results of experiments in a comparatively wide bomb (19 × 10·7 cm. diameter) afford some evidence of auto-ignition during the progress of combustion of a vibratory character in certain acetylene mixtures. The influence of lead tetra-ethyl on the rate of uniform movement of flame is recorded for various acetylene and pentane mixtures, the combustion of pentane being delayed by this substance. T. H. P.

689. Sensitivities of Detonating Compounds to Frictional Impact, Impact and Heat. C. A. Taylor and W. H. Rinkenbach. *Frank. Inst., J.* 204. *pp.* 369–376, *Sept.*, 1927.

Sensitivity to frictional impact is measured by a small pendulum friction machine, the shoe and impact block being of soft steel, and the impact block slightly concave and its central portion transversely scored to prevent the light crystalline material being swept away. An adjustment is made of the weights added to the shoe and the height of fall. In the impact machine weights are allowed to fall from a measured height on to the plunger under which a layer of the explosive is placed. To obtain reproducible results it is found necessary to provide smooth surfaces of steel of constant hardness for the impact block and the plunger tip. Sensitivity to heat is measured by bringing a bath of Wood's alloy to a definite temperature and allowing samples of from 0·005 to 0·05 gm. of the explosive to fall on the surface. The temperature at which explosion takes place within one second is taken as the ignition temperature. The compounds measured include fulminates of mercury and silver, azides, picrates, silver acetylide and potassium chlorate. It is found that a direct relationship between the values for different substances by any one test does not exist, but that, on division into classes, averages indicating a general correlation are obtained. It is thus seen that sensitivity is not specific towards any one form of physical influence. J. N. P.

690. Entropy and "Entropy Constant" of Gases and Gaseous Mixtures and the Precise Physical Definition of "Elementary Volume." J. J. van Laar. *ZS. f. Phys.* 45. 9–10. *pp.* 635–649, 1927.

A homogeneous expression is deduced for the entropy of gases and gaseous mixtures, which, near the "characteristic" temperature (θ), contains the so-called "elementary volume" $\omega = v_b - b_a$. The expression found for ω is identical with the expression for the previously described "entropy constant." The "Gibb's paradox" for the entropy of gaseous mixtures is treated and developed from the expression for Ω. When combined with the known laws of probability, the paradox can be fully explained. The paper is theoretical. S. G. B.

SOUND.

691. Self-Sounding Crystal as a Thermal Effect. Franziska Seidl. *Ann. d. Physik*, 84. 3. *pp.* 384–394, *Oct.* 18, 1927.

A record of experimental work on the production of sound by crystals in contact with the electrodes of various arcs. The Lossew singing arc was first used, and it was found that at the contact point (metal electrode-crystal) a purer stable tone was produced. The author discusses the effects of superimposition of a strong magnetic field, electromagnetic vibrations and oscillatory circuits, and finally gives an experimental method and results of work at higher temperatures, both in oil, air and a vacuum. S. G. B.

692. Vibration Frequencies in Coupled Systems. E. Waetzmann and K. Schuster. *Ann. d. Physik*, 84. 4. *pp.* 507–524, *Nov.* 2, 1927.

The three systems employed consisted of telephone membranes and cylindrical air spaces surrounded by rigid walls. In I the air column was enclosed by a membrane at one end and a stiff wall at the other. In II the air column was of smaller diameter than the membrane, whilst in system No. III the air column was confined between two membranes. A membrane was excited by means of a hummer of variable frequency, and its frequency found by the use of a frequency meter. The length of the air column could be varied from 1 cm. to half a wave-length of the fundamental tone of the membrane. The frequencies for maximum resonance were determined by experiment, and agreed closely with the natural frequencies of the system as calculated by the method of Hahnemann and Hecht [see Abstract 413 (1920)]. The results are shown in graphs, and the mode of coupling in each system is explained. [See also next Abstract.] G. E. A.

693. Theory of the Coupled Vibrations of Telephone Membranes and Air Spaces. K. Schuster. *Ann. d. Physik*, 84. 4. *pp.* 525–552, *Nov.* 2, 1927.

The vibrations of the coupled systems dealt with in the previous paper [see preceding Abstract] are investigated theoretically, and a solution is obtained, with the aid of Ritz's method [see Abstract 772 (1909)], which can be taken to any required degree of accuracy. The approximate expression for the frequencies of the system, for different lengths of cylindrical air space, is derived again by another method. G. E. A.

694. Theory of the Elastic Pianoforte Hammer. P. Das. *Phys. Soc., Proc.* 40. *pp.* 29–35, *Dec.*, 1927.

In previous papers exact expressions have been obtained for the vibrations set up in a string by the impact of an inelastic and also of an elastic hammer. By making various approximations, the influence of which is examined in the present investigation, formulæ are obtained from which it is easy to deduce the practical effect of the elasticity and velocity of the hammer, and of the position of its point of impact on the string. AUTHOR.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

695. Electric Phenomena in Gravitational Fields. E. T. Whittaker. *Roy. Soc., Proc.* 116. *pp.* 720–735, *Nov.* 1, 1927.

Throughout this paper the effect on the space-time metric of the electromagnetic fields concerned is neglected. The gravitational fields considered are (*a*) that of a gravitating centre, with the metric specified by Schwarzschild's formula, and (*b*) the quasi-uniform gravitational field which is obtained as a limiting form of (*a*) when the gravitating centre is removed to an infinite distance from the field point, whilst its mass is increased so that the " attractive force " at the field point remains finite. The general equations of the electromagnetic field in the presence of these two types of gravitational field are derived, and particular solutions found which are the analogues of well-known particular solutions in classical electromagnetic theory. The problems solved include the fields due to electrons at rest, electrostatic fields in general, and spherical electromagnetic waves. W. S. S.

696. Maxwell's Stress and its Time Rate of Variation. S. R. Milner. *Phil. Mag.* 4. *pp.* 943–949, *Nov.*, 1927.

The Maxwellian stress system at a point of the electromagnetic field is shown to be conveniently expressed in terms of two vectors, $p = e\cos\alpha + h\sin\alpha$ and $q = -e\sin\alpha + h\cos\alpha$, where $\tan\alpha = (2eh)/(e^2 - h^2)$. The principal stresses then become $\Pi_1 = -\frac{1}{2}(p^2 - q^2)$, $\Pi_2 = \frac{1}{2}(p^2 - q^2)$, and $\Pi_3 = \frac{1}{2}(p^2 + q^2)$. The time variation of the stress system is most simply given by formulæ for the rates of increase of p^2 and q^2, and for the angular velocity of rotation, ω, of the stress axes. It is found that $\frac{\partial}{\partial t}(\frac{1}{2}p^2) = cp \operatorname{curl} q$ and $\frac{\partial}{\partial t}(\frac{1}{2}q^2) = -cq \operatorname{curl} p$. The angular velocity ω takes the form $\omega = \omega' + c\nabla\alpha$, where ω' depends only on p and q and their space derivatives. In an " orthogonal " field (h and e perpendicular) $\alpha = 0$ everywhere, and the whole subsequent changes in the field are determined by the stress system. W. S. S.

697. Spectroscopic Determination of *e/m*. W. V. Houston. *Phys. Rev.* 30. *pp.* 608–613, *Nov.*, 1927.

Rydberg constants for hydrogen and helium: By an interferometer method the wave-lengths of the hydrogen lines at 6563 Å, and 4861 Å, were measured with reference to λ5015·6750 of He as standard. The values so obtained were, for the doublet at 6563 Å., 6562·7110 ± 0·0018 and 6562·8473 ± 0·0009; and for the doublet at 4861, 4861·2800 ± 0·0013 and 4861·3578 ± 0·0022. Similarly the wave-lengths of the 4686 lines of ionised helium were found to be 4685·7030 ± 0·0012 and 4685·8030 ± 0·0026. From these values of the wave-lengths the Rydberg constant for hydrogen, R_H, is calculated to be 109,677·759 ± 0·008, and the Rydberg constant for helium, R_{He}, to be 109,722·403 ± 0·004.

Calculation of e/m. The ratio of the mass of the electron to the mass of the hydrogen nucleus, m/m_H, is given by

$$m/m_H = (R_{He} - R_H)(m_{He} - m)/R_H(m_{He} - m_H) = 1\cdot33648(R_{He} - R_H)/R_H.$$

The value of e/m is given in terms of the Faraday constant as $e/m = (m_H/m)(F/m_H)$. If the values of R_H and R_{He} calculated above be substituted in these expressions, and if it be assumed that F = 96,470 abamperes per gm. mol. and $m_H = 1\cdot0072$, it is found that e/m has the value $(1\cdot7606 \pm 0\cdot0010) \times 10^7$ e.m.u. per gm. AUTHOR.

698. Electrification of Dielectrics. D. Nukiyama and K. Nakata. *Phys. Math. Soc. Japan, Proc.* 9. *pp.* 114–140, *June–July*, 1927. *In English.*

This paper deals with experimental results relating to the electrification of dielectrics caused by detaching them from other materials without friction between the surfaces of contact. The samples and experimental arrangements are first described, then the following points are considered: charge on specially constructed fabrics ; electrification of solid dielectrics in contact with mercury, *e.g.* stratified dielectrics; measurements of charge on stratified dielectrics; variation of the charge with the time; electric charge produced on solid dielectrics in contact with mercury; dependence of charge upon the height of fall of the dielectric on the mercury surface; charge on the dielectrics when the metal plates put on their surfaces are torn off. A. E. G.

699. Electrostatics of the Thunderstorm. A. W. Simon. *Frank. Inst., J.* 204. *pp.* 617–647, *Nov.*, 1927.

The author examines first the general facts regarding charges and potential in a thundercloud, the potential difference between the top and bottom of the cloud, induced charges on the ground and possible horizontal potential differences in the cloud. The normal loss of electricity from the cloud during rainfall is considered and the conditions under which negatively charged rain may fall. It is emphasised that to obtain the polarity of a cloud that of the rain over an extensive area must be examined. To deduce the direction of the flash from the change in gradient, the nature of the flash, *i.e.*, cloud to cloud or cloud to earth, and the location of the point with respect to the flash must be known. Among the secondary effects discussed are the release of bound charges after cloud to cloud discharges and surges along electrical transmission lines. It is shown that the sudden application of electric stress and the impulsive rush discharge require special conditions and are very infrequent. Finally, numerical values of potential gradient and charge are examined. R. S. R.

DISCHARGE AND OSCILLATIONS.

700. Condenser Discharges in Discharge Tubes. Part I. Single Condenser Discharge. W. Clarkson. *Phil. Mag.* 4. *pp.* 1002–1015, *Nov.*, 1927.

The rôle of the volt-ampere characteristic and the sequence of phenomena in the condenser discharges in discharge-tubes are considered. The fall of voltage (Δ_N) during "clear-up" associated with various points on the characteristic (v_n, i_n) is studied with different capacities (C). Δ_N is found to be proportional to $\sqrt{i_n/C}$, and the time of clear-up, θ_N, to $1/\Delta_{\mathrm{N}}$. Such relations are qualitatively explainable from a rapid increase of clear-up with reduction of voltage. The variation of the final voltage (V_{N}) with the capacity (C) and the initial voltage (V_{M}), corona and normal flashes, and the transition V_{M} are studied. The maximum currents (i_m) attained are deduced from V_{M} and the clear-up curves; i_m increases with C and V. Numerical values are given. Corona flashes demonstrate a slow build-up. Their times of duration (θ) are obtained qualitatively. The data at the transition V_{M} is employed to determine the actual current-voltage relations during discharge, and also to determine the duration of built-up (θ). Current-time curves are of somewhat exponential form with a very slow increase of current initially. The rate of build-up increases rapidly with voltage. A. E. G.

701. Condenser Discharges in Discharge Tubes. Part II. The Intermittent Discharge. W. Clarkson. *Phil. Mag.* 4. *pp.* 1341–1355, *Dec.*, 1927.

The sequence of phenomena and the variations of the maximum and minimum voltages (V_{C} and V_{B}) in the intermittent discharge are studied. The rate of charge is shown to be the significant variable. The theory of the corona lag at " build-up " is discussed. It explains the V_{C} variations. The additional variations at higher frequencies are due to " overlapping " of discharge. Both the lag (θ) and the striking potential (v_m) are lowered. V_{B} variations under constant clear-up conditions (constant final voltage, V_{N}) are examined. Current-voltage-time relations for clear-up are obtained. The current falls with time in a somewhat exponential manner. Times are of the order 0·02–0·05 sec. V_{B} variations in intermittence are shown to depend on the variation of clear-up with V_{C} and the rate of charge. The time of clear-up (θ_{N}) is obtained from the graphs. The timing relation, $T = CE/i$, is discussed. E is everywhere greater than $V_{\mathrm{C}} - V_{\mathrm{B}}$. At " overlapping " $T = \theta + \theta_{\mathrm{N}}$. θ_{N} values so derived differ from those determined graphically. This is shown to be in accord with theory, as are the apparent timing anomalies due to erratic lags. Corona lag variations are briefly discussed. A. E. G.

702. Electrodeless Discharge through Gases. J. J. Thomson. *Phil. Mag.* 4. *pp.* 1128–1160, *Nov.*, 1927. *Supplement.*

This paper gives a discussion of the theory of the electrodeless discharge produced when a vessel containing gas at a low pressure is placed inside a solenoid through which pass rapidly alternating currents due to the discharge of Leyden jars. It is shown that to produce the discharge the maximum magnetic force inside the solenoid must reach a value which depends on (1) the nature of the gas, (2) its pressure, (3) the frequency of the currents, and (4) the size of the vessel. This value is infinite when the pressure is either zero or infinity; it is a minimum when the pressure is such that $\lambda p = c$, where λ is the free path of the electron in the gas, p the frequency of the alternating current, and c the velocity of the electron when its energy is that required to ionise the gas. Thus there is a critical pressure when the discharge passes most easily, and this depends on the frequency of the currents. The theory is confirmed by experiments. In the electrodeless discharge very large currents may pass through the gas without visible luminosity; thus processes must occur in addition to the passage of a current. Within a certain range of pressures the gas is in a " sensitive " state, and the discharge has peculiar properties. Within a limited range of pressure and current density striations occur in the electrodeless discharge in hydrogen. At high pressures the luminosity is confined to a ring, while at low pressures it extends on either side, forming a double cone with the ring as base. Study of this outlying luminosity leads to very interesting results in connection with the origin of visible radiation. Remarkable effects occur when certain solids are placed at the centre of the ring. Some cause weakening or stoppage of the discharge, but others facilitate it. A theory of this effect is discussed. J. J. S.

703. Electric Discharge in Rarefied Gases. Distribution of the Electric Field in the Dark Space. M. Morand. *J. de Physique et le Radium*, 8. *pp*. 451–472, *Nov*., 1927.

According to the ideas developed by Townsend and others the persistence of the discharge in a rarefied gas is due both to ionisation by positive rays and to the kathodic emission. A simple and general method of calculation is here used to show that the experimental laws discovered with regard to the distribution of the electric field in the dark space are only explicable if positive-ray ionisation is effective. If λ is the mean free path given by the kinetic theory for an ordinary molecule, comparison of experimental curves with theoretical results shows that (1) for the positive rays, whose mean free path is, on account of their velocity, equal to $\lambda\sqrt{2}$, the calculated ionising power is near that determined by Townsend; (2) the kathode rays, whose mean free path is $4\lambda\sqrt{2}$, produce on an average two ions for every three or four impacts; (3) the current of positive ions issuing from the negative glow is, in general, only a small fraction of the total current traversing the discharge tube; (4) the kathodic emission represents an appreciable fraction of the total current in the tube. In the majority of cases kathodic emission gives to the discharge a certain instability. The current traversing the tube can only be constant if a certain condition relative to the number of ions formed in the dark space by the kathode rays is fulfilled. When this condition is satisfied, ionisation by positive rays should necessarily take place also. Thus the conclusions are in agreement with Townsend's results. A. W.

704. Electric Discharge in a Liquid Medium. Part II. H. Obata and N. Nakanishi. *Electrot. Laborat. Tokyo, Japan, Researches, No*. 204. [31 *pp*.], *June*, 1927.

For Part I see Abstract 159 (1928).

705. Gaseous Combustion in Electric Discharges. Part II. Ignition of Electrolytic Gas by Direct-Current Discharges. G. I. Finch and L. G. Cowen. *Roy. Soc., Proc*. 116. *pp*. 529–539, *Nov*. 1, 1927.

Ignition of electrolytic gas by means of a direct-current discharge occurs without lag immediately on attainment of the igniting current. Over a considerable range of conditions the gas pressure and the igniting current strength are connected by a hyperbolic relationship. The value of the igniting current is increased by either deficiency or excess of water vapour in the gas in the ignition zone or by decrease in the width of the gap, which results in broadening of the bright positive glows. The rate of propagation of the flame in electrolytic gas is at least ten times as great along the path of the discharge as elsewhere in the explosion vessel. These results indicate that the ignition is conditioned by the attainment, in some portion of the gas traversed by the discharge, of a certain definite concentration of suitable ions or electrically charged particles in the construction of which water vapour materially assists, and that the propagation of flame is essentially an electrical phenomenon. [See Abstract 1886 (1926) for Part I.] T. H. P.

706. Temperature Measurements and Catalytic Wall Action in the Glow Discharge. R. Seeliger and H. Straehler. *Phys. Zeits.* 28. *pp.* 894–904, *Dec.* 15, 1927.

This paper forms a continuation of previous work by one of the authors [see Abstract 758 (1927)] on the measurement of temperature in the unstratified positive column of the glow discharge. The results here obtained add greatly to the value of the conclusions arrived at. A. E. G.

707. The Electric Arc. K. T. Compton. *A.I.E.E., J.* 46. *pp.* 1192–1200, *Nov.*, 1927. *Abstract.*

The arc is here defined as a discharge of electricity, between electrodes in a gas or vapour, which has a voltage drop at the kathode of the order of the minimum ionising or minimum exciting potential of the gas or vapour. Arc characteristics are discussed, including the relation of arcs to glow discharges and coronas. The kathode spot, theories of kathode fall, and the energy balance at the kathode are the other chief points considered. A useful bibliography is appended. A. E. G.

708. A New Photoelectric Theory of Sparking Potential. J. Taylor. *ZS. f. Phys.* 45. 9–10. *pp.* 620–624, 1927. *Roy. Soc., Proc.* 117. *pp.* 508–517, *Jan.* 2, 1928.

According to this theory the spark tension is a function of the photoelectric emissive energy of the kathode for the radiation emitted from the kathode surface when the positive ion is neutralised. The paper describes the experimental tests with an illustration of the apparatus employed, and claims that the results are in close agreement with the theory. [See Abstract 1849 (1927).] E. F.

709. Critical Velocities for the Secondary Kathode Radiation released from Tungsten by Electronic Impact. H. E. Krefft. *Ann. d. Physik,* 84. 5. *pp.* 639–673, *Nov.* 19, 1927.

When metals are bombarded by electrons the velocity of which is gradually increased, and the current due to the secondary electrons given out by them is measured, the effect of occluded gases is very marked, and it is impossible by studying the graph to recognise the " nicks " which correspond to the excitation of the different electronic levels in the atom of the metal. The author has devised an apparatus in which the bombarded tungsten can be heated to temperatures up to 1450° K., and the currents can be measured while it is heated and practically free from gas. A number of " nicks " are then found in the graph which correspond in position to the critical excitation tensions which have been found by Richardson and Chalkin in the soft X-radiation of tungsten. H. N. A.

710. Passage of Slow Kathode Rays through Metals. A. Becker. *Ann. d. Physik,* 84. 6. *pp.* 779–806, *Dec.* 3, 1927.

An investigation of the passage of slow kathode rays through metal layers of nickel, gold and aluminium is described. Both the number and the velocity distribution of the electrons behind the metal layer were measured as regards their dependence on the velocity of the incident rays. The electrons behind the metal layers fall generally into four groups: (i) Secondary electrons. These in most cases greatly preponderate. Their relative number increases greatly with decreasing ray velocity to about 500 volts and then decreases. Their most probable velocity, independent of the primary velocity, is about 2 volts. (ii) Primary electrons with velocities varying continuously between nearly zero and a definite maximum. These are entirely lacking when the thickness of the metal layer is sufficiently great. (iii) Electrons with a definite velocity range. The velocity of these is generally less than that of the primary rays but has a certain relation with the primary velocity. (iv) Unretarded primary rays which were observed in a few cases with great primary velocities. The transparency of a layer decreases rapidly in general as the ray velocity decreases, but finally appears to reach a lower limit. In a few cases a strongly selective transparency was observed for definite ray velocities when the layer was almost completely opaque for velocities above and below these velocities. In such cases the emerging rays were appreciably slower than the incident rays. The absorption by metal layers for low velocities relative to air is appreciably less than proportional to the mass. The velocity loss for slow kathode rays follows, in its dependence on the velocity, nearly the same law as that for α-rays. A. W.

711. Oxide Kathodes. W. Statz. *Zeitschr. f. tech. Phys.* 8. 11. *pp.* 451–456, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

Three different methods of setting up oxide kathodes are here described. A diagram is given illustrating the American method of preparing oxide kathodes, also a photograph of the arrangement used for the automatic preparation of an oxide kathode according to the melting process. The properties of the various kathodes is discussed in comparison with the properties of wolfram and thorium kathodes. A. E. G.

712. Diffraction of Electrons by a Nickel Crystal. C. Davisson and L. H. Germer. *Phys. Rev.* 30. *pp.* 705–740, *Dec.*, 1927.

The intensity of the scattering of a homogeneous beam of electrons of adjustable velocity incident on a single crystal of nickel has been measured as a function of direction. The crystal was cut parallel to a set of its (111) planes and bombardment was at normal incidence. The distribution in latitude and azimuth was determined for such scattered electrons as have lost little or none of their incident energy. Diffraction beams due to adsorbed gas were observed except when the crystal was thoroughly cleaned by heating. The structure of the gas film has been deduced. A. B. W.

713. Relation between the Secondary Electron Emission from Nickel and Tungsten and its Temperature. H. Nukiyama and H. Horikawa. *Tohoku Univ., Technol. Reports,* 7. 1. *pp.* 49–56, 1927. *In English.*

This is an account of some preliminary work on the subject, and the following are the main points considered: The construction of the valve;

the evacuation; the diagram showing the connections used; anode current; anode voltage characteristics; the change in the apparent secondary electron emission with anode temperature; the relation between the critical potential and the temperature. A. E. G.

714. Electron Currents in Mercury-Vapour Discharges. E. Lübcke. *Zeitschr. f. tech. Phys.* 8. 11. *pp.* 445–449, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

The analysis of wall currents of a mercury-vapour discharge into ion- and electron-parts is here described. The ion current of order of magnitude 50 milliamps. is received on a guiding grid, the anode current on a guiding anode. By altering the grid tension a few volts the anode current can be altered some 5 amps. with an anode tension of 200 volts. An increase of the electron currents in tubes of the same diameter can be obtained by increasing the number of guiding arrangements in the tube. Measurements are given for a tube with five guiding arrangements. A. E. G.

715. Mobility of Ions in Gases. M. Laporte. *Ann. de Physique*, 8. *pp.* 466–554, *Nov.*, 1927.

The principal results of the experiments described are as follows. An entirely new method of measuring the mobility of ions in gases is established, the essential feature of the apparatus being its power of separation. It is now found possible to obtain in approximate manner the curve of distribution of ions of different mobilities; a sort of spectrometer of mobilities is also instituted. The study of the curves obtained in air, oxygen and nitrogen enables it to be shown that the negative ions in air are solely ions of oxygen. The differences of electronic affinities are also shown. These results establish that the constitution of the atom plays an important part in the mechanism of the formation of ions, a formation which, from this point of view, must be considered as a chemical reaction of a particularly simple nature. Continuing and extending the results of Franck and Pohl, the author has shown, in collaboration with da Silva, that in perfectly pure argon all electrons remain free. The ionisation curves become deformed when impurities are introduced into the argon. An attempt is made to point out that the theories discussed are not compatible with experimental results, and an endeavour is made to explain the constitution of ions in such a way as to overcome this difficulty. An important point in the explanation is the prominent part attributed to water in the formation of ions. A. E. G.

716. Obtaining an Intense Beam of Low-Velocity Electrons. H. E. Farnsworth. *J.O.S.A. and R.S.I.* 15. *pp.* 290–294, *Nov.*, 1927.

An improved method, substituting cylinders for diaphragms. The scattering is negligible even when the average equivalent energy of the electrons is as low as 0·5 volt, and the velocity of the electron beam is very uniform. A. D.

717. Refraction of Electromagnetic Waves in a Spherically Stratified Medium. T. Y. Baker. *Phil. Mag.* 4. *pp.* 955–980, *Nov.*, 1927.

Certain well-known considerations make the investigation of the paths of light waves and wireless waves exceedingly complicated, and it is only the hypothetical cases in which some of the governing factors are omitted that rigorous mathematical treatment is possible. In this paper such a course is followed. Nothing but straightforward refraction is considered. All diffraction effects, all absorption effects, all surface reflection effects, whether at the earth's surface or possibly at the Heaviside layer, are left out of account, and the investigation aims at showing what kind of physical effects in the reception of wireless signals, or in the distance and depression of the visible sea-horizon, will be found in this hypothetical atmosphere. No attempt is made to discuss the physical conditions, such as density, degree of ionisation, etc., at any point that produce the particular refractive index at that point, except that it is assumed that refractive index is a function of wave-length, and that consequently the distribution of refractive index with height is not necessarily the same for one wave-length as for another. With those limitations, there is investigated for this hypothetical atmosphere what must be the nature of the distribution of refractive index that will allow of a transmission of energy completely round the earth and that will give rise to such phenomena as the " skip " distance. Within the region of the visible spectrum the refractive effects that give rise to a triple horizon, sometimes termed mirage, are considered. A. E. G.

718. Small Rectifiers for Wireless. M. Bareiss. *Zeitschr. f. tech. Phys.* 8. 11. *pp.* 449–451, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

In this paper the construction of small tubes as rectifiers is considered from the point of view of measurements. The following are the three types dealt with : high vacuum rectifier with glow-kathode; gas-filled, glow-kathode rectifier for higher and lower tensions; glow rectifier. A. E. G.

719. Dispersion and Absorption of Short Electric Waves. W. I. Romanoff. *Phys. Zeits.* 28. *pp.* 770–779, *Nov.* 15, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

A critical discussion is given of the experimental results of Colley, Frankenberger, Potapenko and numerous others with reference to the theory of molecular resonance and to Debye's dipole theory. A. W.

720. Development in the Manufacture of Electron Tubes. H. Simon. *Zeitschr. f. tech. Phys.* 8. 11. *pp.* 434–445, 1927. *Paper read before the Deut. Physikertag., Kissingen, Sept.*, 1927.

This paper contains a general account of the developments which have taken place during the last year in the manufacture of electron tubes. The following are among the principal points dealt with: materials of the glow-kathode; grid and anode materials; development and build of receiver tubes; especial receiver-tubes construction; kathode materials for transmitter tubes; especial transmitter tubes construction; disturbance phenomena in transmitter tubes. A. E. G.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

721. Effect of Iron and Oxygen on the Electrical Conductivity of Copper. R. P. Heuer. *Am. Chem. Soc.*, J. 49. *pp.* 2711–2720, *Nov.*, 1927.

The discordance in the data published on the electrical conductivity of dilute solid solutions of metallic elements in copper is pointed out, and the work of Hanson and Ford [see Abstract 757 (1925)] is in part criticised upon thermodynamic considerations. It is shown that 1 % iron reduces the conductivity of copper at the rate of 630 % of the standard value, and from the quantitative study of the formation of ferrous oxide in alloys of copper, iron and oxygen it is shown that iron can be completely oxidised in alloys containing cuprous oxide eutectic. J. K.

722. Conductivity and Dielectric Hysteresis and the Influence of X-Rays and γ-Rays. H. Neumann. *ZS. f. Phys.* 45. 9–10. *pp.* 717–748, 1927.

Measurements for amber, sulphur and paraffin. The resistance of sulphur was between $2 \cdot 10^{18}$ and $2 \cdot 10^{19}\,\Omega$ cm.; that of paraffin was $3 \cdot 10^{18}\,\Omega$ cm.; that of amber was above $10^{20}\,\Omega$ cm. The charges due to electrical hysteresis were after a period of charge of five hours about $\frac{1}{1000}$ the induction charge. X-rays and γ-rays enhance the conductivity of sulphur, while the after-effects are hardly influenced by them. Amber and paraffin show no increase in their conductivity under exposure to 1 mg. of radium. A. D.

723. Electrostriction in Dielectrics. Y. Rocard. *J. de Physique et le Radium*, 8. *pp.* 385–390, *Oct.*, 1927.

Helmholtz, Lippmann, Pockels, Bruhat and Pauthenier have given a correct theory for electrostriction and the variations in the refractive index which follow from it, but only where the index of refraction and the dielectric constant depend only on the density. In terms of differential coefficients it is possible to obtain the variations in the refractive index in the general case, by a general thermodynamical method. The results are nearer to the data of observation than hitherto. **Erratum,** *ibid. p.* 492, *Nov.*, 1927. A. D.

724. Theory of Electrostriction. C. Raveau. *Comptes Rendus*, 185. *pp.* 1121–1124, *Nov.* 21, 1927.

Rocard has put forward an important thermodynamic formula generalising the theory of Bruhat and Pauthenier [see Abstract 1195 (1925)] which permits the numerical calculation *à priori* of the variations of the indices of refraction in adiabatic electrostriction, and allows the consequences relative to the value of the ratio of the absolute retard in the phenomenon of Kerr, and to the theory of diffusion of light. The present paper is of a mathematical nature, and discusses and criticises the equations obtained. **Erratum,** *ibid. p.* 1228, *Nov.* 28, 1927. A. E. G.

725. Variations of the Specific Inductive Capacity of Liquids in Powerful Electrical Fields. L. Cagniard. *Comptes Rendus*, 185. *pp.* 1195–1197, *Nov.* 28, 1927.

Herweg's calculations [see Abstract 715 (1921)] are incomplete, and the production of bipoles in powerful fields is not established. A. D.

726. High-Frequency Measurement of Dielectric Constants in Liquids. R. Darbord. *Comptes Rendus*, 185. *pp.* 1193–1195, *Nov.* 28, 1927.

Introduces a new method of direct measurement without dispersion of the lines of force, in terms of absolute units, without the use of a standard of comparison. A. D.

727. Dielectric Constants of Gases. Cordonnier and Guinchant. *Comptes Rendus,* 185. *pp.* 1448–1450, *Dec.* 19, 1927.

The dielectric constants of about thirty gasses have been measured at 150 kilocycles, and are tabulated. The dielectric constant of a mixture of gases with partial pressures P_n is given by $P(K - 1) = \Sigma P_n(K_n - 1)$. This relation is applicable to humid air. The ratio of the molecular refraction to the Lorenz constant is not a constant. A. Wh.

728. Dielectric Hysteresis. H. Saegusa. *Tohoku Univ., Sci. Reports,* 16. *pp.* 815–824, *Oct.,* 1927. *In English.*

From the time-effect an expression for the terminal potential difference of a test condenser is obtained as a function of time and the material constants; and then, summing up the terminal potential for successive chargings and dischargings, and considering the after-effect of the terminal potential, an expression is obtained for the terminal potential at every charging and discharging. Using experimental values of the material constants for quartz plates, and putting the electrical capacity of the test condenser and the applied potential difference always equal to unity and the time interval between two successive chargings and dischargings always equal to 5 seconds, the hysteresis loop for quartz is obtained. The results coincide closely with former experimental results. The plastic dielectric hysteresis is formed by the time-effect of chargings and dischargings. A. D.

729. Photoelectric Threshold of Single Bismuth Crystals. T. J. Parmley. *Phys. Rev.* 30. *pp.* 656–663, *Nov.,* 1927.

A bismuth single crystal grown by Bridgeman's method was mounted in a specially constructed, highly evacuated bell jar. By means of external magnet control it was possible to cut the specimen along a crystal face and advance it into position in a Faraday cylinder. Photoelectric current fatigue curves were taken for the 2537 Å. line under three different vacuum conditions. It was found that the fatigue was smaller the higher the vacuum. The long wave-length limit was determined by plotting the current per unit intensity as a function of the wave-length of the mercury arc used. The threshold was determined under the two following conditions: (1) after the new surface had aged an hour in a vacuum of the order of 10^{-6} mm.; and (2) immediately after cutting a new face in a vacuum of the order of 10^{-7} mm. The two values were 2567 Å. and 2835 Å. respectively. Similar observations on the polycrystalline form yielded the values 2560 Å. and 2830 Å. Experiment showed that the threshold changed rapidly from 2835 Å. to 2567 Å. in the low vacuum. It was found that this shift was not due to oxygen, nitrogen, or carbon dioxide, the chief constituents of air, but to some other source of contamination which was not located. AUTHOR.

730. Photoelectric Effect and Surface Structure in Zinc Single Crystals. E. G. Linder. *Phys. Rev.* 30. *pp.* 649–655, *Nov.,* 1927.

A single crystal of zinc, cylindrical in form and with the hexagonal axis perpendicular to the axis of the cylinder, was mounted in a photoelectric tube and a narrow strip of its surface parallel to the axis of the cylinder illuminated with ultra-violet light. A variation of the photoelectric current was observed as the crystal was rotated. The maximum current was obtained when the hexagonal axis was normal to the illuminated surface and the minimum when it was parallel. The ratio was about 2 : 1. The effect with polarised light was the same as with unpolarised. A study of the evaporated surface showed that it was made up of microscopic crystal facets. The albedo was found to be about 0·22, and was the same for all portions of the surface. AUTHOR.

731. Hall Effect and Resistance in Sputtered Tellurium Films. F. W. Warburton. *Phys. Rev.* 30. *pp.* 673–680, *Nov.*, 1927.

Aside from an ageing process, the Hall e.m.f. was found to be directly proportional to the resistance both when the temperature coefficient of resistance was negative and when it was positive. The films were from 10^{-5} to 10^{-6} cm. thick. Heating the film in a gas (air or hydrogen) when the film was not completely aged brought departures from the proportionality between the Hall e.m.f. and the resistance, while pumping out and cooling returned the film to its previous condition. AUTHOR.

732. Photoelectric Conduction in Selenium. R. J. Piersol. *Phys. Rev.* 30. *pp.* 664–672, *Nov.*, 1927.

A selenium cell is described which gives a photo-current of 10 milliamperes for a difference of potential of 100 volts and an illumination of 100 foot-candles. The sensitiveness ratio between the currents under light and dark conditions is 100. The characteristics of the cell are very constant. The experimental results establish the existence of a linear relation between the square of the photo-current and the light intensity. It is pointed out that this result substantiates the conclusion that the photoconduction in selenium is due to a photoelectric liberation of electrons rather than to an allotropic change from an insulating to a conducting form of selenium. Under dark conditions the current through a cell immersed in liquid air dropped in 15 secs. to 35 % of its value at room-temperature, and in 10 mins. to 0·000046 %. When the same cell was illuminated with 100 foot-candles and immersed in liquid air, the current increased for 8 mins. to about 1·8 times its value at room-temperature, and then decreased until after 3 hours its value was 82 % of its value at room-temperature. It is concluded that the mechanism of the current conduction under dark conditions is entirely different from that of the photo-conduction. AUTHOR.

733. Photoelectric Cell for Medium Ultra-Violet. L. Mallet and R. Cliquet. *Comptes Rendus*, 185. *pp.* 1031–1033, *Nov.* 14, 1927.

The potassium hydride cell is not sensitive to wave-lengths below 3600 Å. Zilard has constructed a cadmium cell sensitive as far as 2900 Å. The authors adopt an alloy of cadmium and silver, which is quite insensible to the visible spectrum, but shows a maximum photoelectric effect at 2536 Å. E. E. F.

734. A New Form of Voltmeter for Measuring Average Voltage for Alternating Currents. J. Taylor. *Phil. Mag.* 4. *pp.* 1356–1358, *Dec.*, 1927.

In a previous paper [see Abstract 1114 (1926)] the author has considered an application of the diode to the measurement of a.c. voltages. In the present method a triode, of which the grid and plate are short-circuited, is connected in series with a resistance and a micro-ammeter is employed. A diagram showing the connections of these and the voltage to be measured is given. The theory of the method is discussed. The instrument is useful for the comparative measurement of square voltage wave-forms, such as are given by certain types of commutators supplied by direct voltage and for those approximately square voltage forms associated with the condenser "flashing" in low potential intermittent discharges. It is also possible to use the voltmeter for the measurement of alternating current. There is no necessity for frequent calibration. A. E. G.

735. The Temperature-Electrical Resistivity Relationship in Certain Copper α-Solid Solution Alloys. A. L. Norbury and K. Kuwada. *Phil. Mag.* **4.** *pp.* **1338–1341,** *Dec.*, **1927.**

With alloys containing up to 3 % or 4 % of Al, Sn or Si the specific resistance R_t at any temperature t between − 191° and 438° C. can be calculated from the specific resistance R_0 at 0° C. by means of the equation $R_t = R_0 + (0{\cdot}0064 + R_0 \times 0{\cdot}0002)t$ microhms per cm. cube. For manganese and nickel alloys this is not the case. The general results obtained show that the "atomic effects" of solute elements in increasing the resistivity of the solute have higher values at high temperatures than at low ones, but that they are changed by the same percentage for the same temperature change. This is not exactly the case for the manganese and nickel alloys. H. N. A.

736. Stroboscopic Manometer as Variable Electric Condenser. J. Villey and E. Hochard. *Comptes Rendus*, **185.** *pp.* **1255–1256,** *Dec.* **5, 1927.**

The apparatus is used to give a measure of the variations of pressure during a cycle of air compression. It consists essentually of an elastic metallic membrane which can respond at once to the pressure changes. It is mounted in a differential manometer to eliminate accidental variations. The membrane further acts as an armature varying the capacity of a condenser connected to the one pair of the quadrants of an electrometer, the other pair being joined to a condenser of constant capacity. An interrupter allows contact to the condenser for only $\frac{1}{80}$th of the period, and a stroboscopic method is used to view the position of the spot of light reflected from the mirror on the moving suspension of the electrometer. The apparatus can be calibrated to give pressure readings directly.
R. S. R.

ALTERNATING CURRENTS AND MAGNETISM.

737. Electromagnetic Forces on Current-Carrying Conductors. W. F. Dunton. *Journ. Sci. Instruments*, **4.** *pp.* **440–446,** *Nov.*, **1927.**

The author points out that serious errors are frequently made in the design of electromagnetic devices by using the formula for the field of an infinite straight conductor when the conductor is of finite length. Examples of such errors are given, and correct formulæ are worked out.
AUTHOR.

738. Permeability of Iron at High Frequencies. C. Gutton and (Mme.) J. Mihul. *Comptes Rendus*, **185.** *pp.* **1197–1198,** *Nov.* **28, 1927.**

In continuation of a former investigation [see Abstract 2622 (1927)] the permeability of iron was tested in alternating fields of effective intensity from 0·14 to 5·64 gauss. The wave-length employed was 1290 cm. The mean permeability for a soft iron wire and for a piece of piano wire was found to remain constant for fields up to 1 gauss; thereafter it increased with the field. G. E. A.

739. Magnetic Properties of Thin Films of Electrolytic Iron. E. P. T. Tyndall. *Phys. Rev.* 30. *pp.* 681–691, *Nov.*, 1927.

Films of iron are made by electrodeposition on brass tubes. The thickness ranges from 26·5 to 102 millimicrons. Magnetisation curves and hysteresis cycles are obtained by a magnetometric method. The films show increasing magnetic hardness with decreasing thickness. In a 150-gauss field the maximum intensity of magnetisation reached is 1480 units for a thickness of 50 millimicrons. Thicker and thinner films are slightly less completely saturated. The coercive force, from $H_{max.} = 150$, is related to the thickness as follows: $H_c = 5 \times 10^6/(89\theta + 2260)$, where θ is the thickness in millimicrons. The theory of McKeehan is found adequate to explain the observed magnetic properties, which are traced to the constraint placed on the films by the kathode on which they are deposited. It is further shown that the films when demagnetised must be in a state of tension. Other considerations supporting the views cited are advanced. AUTHOR.

740. New Magnetic Materials. U. Meyer. *Phys. Zeits.* 28. *pp.* 919–920, *Dec.* 15, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

Hysteresis curves are given for an alloy, discovered by Elmen, containing 60 Ni, 15 Co and 25 Fe. The B–H curves are of dumb-bell shape, indicating low remanence and coercive force combined with comparatively high hysteresis. The same general property is found when the proportions of the metals are changed to 50, 30 and 20 respectively. The author found similar behaviour in an alloy containing 53 Ni, 25 Co, 21 Fe and 1 Mn. An explanation of the anomaly is suggested by supposing the alloy to consist of nickel-iron elementary magnets possessing high initial permeability and of cobalt-iron magnets with high coercive force. G. E. A.

741. Magnetic Properties of Single Crystals of Nickel. S. Kaya and Y. Masiyama. *Nature,* 120. *pp.* 951–952, *Dec.* 31, 1927.

The investigation of the magnetic properties of single crystals of iron [see Abstract 1888 (1927)] is extended to nickel. Large crystals were obtained by lowering the molten metal slowly out of an electric furnace. Three oblate spheroids were prepared from the crystals, and examined with respect to their magnetic properties and magnetostriction along the three principal axes. Magnetisability is the same for all three axes for fields up to 205; thereafter I varies for the three axes, the trigonal, digonal and tetragonal axes showing a decreasing order of magnetisation. This is the reverse of the order with iron crystals. The value found for I_s was 503, which lies between those found by Weiss (478) and by Gumlich (509). The different properties are detailed and are illustrated by I–H curves and curves of expansion and field intensity. G. E. A.

742. Magneto-Chemistry of Vanadium. N. Perrakis. *J. de Physique et le Radium,* 8. *pp.* 473–480, *Nov.*, 1927.

The material of two previous papers is here collected [see Abstracts 2618 and 2988 (1927)], and the positions of penta-, tetra- and trivalent vanadium on Cabrera's curve are marked. G. E. A.

743. Magnetic Field of the Lunar Orbit. L. Counson. *Arch. des Sciences*, 9. *pp.* 316–329, *Sept.–Oct.*, 1927.

A comparison has been made between the changes of the magnetic inclination at the Val-Joyeux Observatory and the inclination of the lunar orbit to the equator at different epochs from 1901 to 1920, and a close correspondence is found. In explanation it is stated that the surface of the moon acquires an electrostatic charge, and little loss of this occurs by ionisation of the atmosphere since this is so rarefied. The rapid movement of the moon generates a magnetic field around this moving charge, and this in turn causes induced currents on the earth. The corresponding values are tabulated. R. S. R.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

744. The Distinction between Measurements of Excitability and of the Velocity of Neuro-Muscular Excitability. A New Test of Excitability. P. Fabre. *Comptes Rendus*, 185. *pp.* 1216–1218, *Nov.* 28, 1927.

Nerves and muscles can be classified according to the velocity of their reaction to electrical excitation, but this gives no indication as to their preservation of excitability, and these two properties may cause variations in a given neuro-muscular preparation. The author expresses this by a formula involving a constant, and details experiments with the gastrocnemius muscle of a frog to show how the value of K is related with time and temperature. B. J. L.

745. The Biological Properties of X-Rays of Wave-Length 8 Å. J. Saidman. *Comptes Rendus*, 185. *pp.* 1618–1620, *Dec.* 27, 1927.

It has been noticed by Schultz and by Zehden that X-rays of long-wave lengths have a benign effect on the skin, although X-rays of short wave-length (as usually produced) are dangerous in this respect and have to be filtered out in radiotherapy. Bucky has described a tube producing radiations of 1·5 to 2 Å. (Grenzstrahlen), which has important therapeutical uses. Bucky has suggested that this radiation does not penetrate the skin. Cahen has shown that this is not the case, the radiation penetrating to 2 mm. The present author has utilised a special X-ray tube due to Dauvillier, giving radiation of wave-length as low as 8 Å., and states that in this case the effects are confined to the skin only, have a beneficial therapeutic action, and, whilst giving rise to an erythema, this is quite benign. Experiments carried out with this tube are described, and it has been found to give particularly good results in cases of chronic eczema. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

746. Sorption of Ammonia by Glass. Time, Pressure and Temperature Relationships. M. Francis and F. P. Burt. *Roy. Soc., Proc.* 116. *pp.* 586–602, *Nov.* 1, 1927.

Sorption took place in a bulb containing glass wool, the desiccation of the glass being carried out by a special process which made its behaviour towards ammonia constant. For maximum desiccation the sorption curve is **S**-shaped, only the top portion of the **S** being observed at high temperatures. When log sorption rate is plotted against log time the graph consists of two straight lines joined by a short curve; the slopes of these are independent of pressure, and vary only slightly with temperature. The intersection point corresponds to 50 % of equilibrium sorption, σ, and it appears that the first half of the process is of a different nature from the second, where the rate of change of log ds/dt with log t is more than doubled. The sorption fraction s/σ, where s is the measured sorption and σ the limiting value for $t = \infty$, can be expressed as a single valued function of the product $tp^{4/5}\mathrm{T}^{13 \cdot 7}$, accurately near 50 % sorption and approximately over a wide range; t time from start, p pressure, T centigrade temperature. Laws connecting σ with p at constant temperature and with T at constant pressure were worked out. H. N. A.

747. Adsorption of Butyric Acid on Water Surfaces. C. R. Bury. *Phil. Mag.* 4. *pp.* 980–984, *Nov.*, 1927.

Several authors have already calculated from surface-tension measurements the amount of butyric acid adsorbed on water surfaces; in the absence of activity data, they have assumed the activity of butyric acid to be proportional to its concentration, or to the concentration of its unionised molecules. Recent measurements of the freezing points of butyric-acid solutions by Jones and Bury have shown this assumption to be unjustifiable. It was therefore thought advisable to recalculate the adsorption, making use of the activities deduced by these authors. As a result, it is concluded that butyric acid forms saturated surface layers at the water-air surface, in which the area occupied by a molecule of acid is independent of concentration over wide ranges, but appears to increase slightly with temperature. The area occupied by a molecule at the water-hexane interface is appreciably smaller than at the water-air surface, but still larger than that occupied by the higher, insoluble fatty acids and alcohols. There is no evidence of the formation of a saturated surface layer at the water-benzene interface. A. E. G.

748. Structure and Formation of Colloidal Particles. H. Freundlich. *Faraday Soc., Trans.* 23. *pp.* 614–623, *Nov.*, 1927. *Paper read before the British Assoc., Leeds, Aug.*, 1927.

To gain an insight into the structure of colloidal particles the author discusses states of aggregation, crystalline form and shape. The two former are investigated by means of X-ray diagrams, the latter by optical devices, and a survey of these methods is given. The conditions of formation of colloidal particles are next considered, in which a competition appears to occur between a grouping and an orientation velocity. A

bird's eye view of the development of the knowledge with respect to the structure of colloidal particles is illustrated by taking the colloidal solutions of iron oxide prepared by hydrolysing iron chloride solutions. X-ray diagrams, measured by Boehm in 1925, indicate a crystalline character for the above particles, and their chemical substance that of a basic iron chloride, whilst the behaviour of the Tyndall-light in flowing sols points to a plate-like structure. The layers were destroyed by shaking, but reformed on standing, although irreversible coagulation occurred with electrolytes. If the layers were moved carefully by gentle flowing of the liquid or through the influence of a magnetic field, the plates of each single layer were orientated still more regularly than they were originally, and flexional birefringence and dichroism caused.
H. H. Ho.

749. The Constitution of Colloidal Platinum. S. W. Pennycuick. *Chem. Soc., J. pp.* 2600–2613, *Oct.*, 1927.

Colloidal platinum prepared in water of specific conductivity 0·4 gemmho, and rigorously kept free from contamination, can be made to yield a specific conductivity of 41·2 gemmhos at 25°. It is suggested that oxidation accompanies the sparking process, and that a colloidal complex acid is formed. Pure platinum sols have been titrated with various bases, and the titration curves are discussed. Whilst the platinum sols titrate more like strong acids than weak acids, they cannot strictly be compared with either. There appears to be a slow equilibrium between the diffused hydrogen ions and the hydrogen ions held at the surface of the complex platinum anion. A similar equilibrium exists for any other added kation. The consequences of the slow velocities of these equilibria are discussed.
J. N. P.

750. The Viscosity Factor in Emulsification. R. C. Smith. *Phil. Mag.* 4. *pp.* 820–826, *Oct.*, 1927.

Attention is drawn to the fact that Plateau investigated the phenomenon of surface viscosity. Many experimenters have referred to Plateau's work, but have considered chiefly the viscosity of the dispersion medium. The viscosity of the interfacial film, especially that produced when a solid is introduced into the interface, has now been investigated. It is shown that solids giving good emulsifiability give as a rule high interfacial tensions.
J. N. P.

751. Conductivity of Salt Solutions in Presence of Agar. E. Iwase. *Kolloid Zeits.* 43. *pp.* 70–72, *Oct.*, 1927.

The specific conductivity is measured of solutions of potassium sulphate, chloride, iodide, and sulphocyanide, and sodium chloride when alone and when in presence of agar in sol and in gel form. The results are in agreement with the observations of Hatschek and Humphry that the solutions in the gel medium have a slightly higher conductivity than those in the sol. The results are also in accordance with the view of v. Wiemarn that gelatinisation is accompanied by a lowering of the surface through aggregation or enlarging of the colloid particles, and adsorbed electrolyte is thereby released and increases the conductivity. By regarding the agar-water-salt system as heterogeneous, it is shown that the amount of salt adsorbed on the particles of the agar can be determined from the conductivity values.
J. N. P.

752. Heat of Dilution of Solutions of Weak Concentration. S. M. Naudé. *Z. El. Ch.* 33. *pp.* 532–534, *Nov.*, 1927.

Referring to Nernst's theory [see Abstract 505 (1928)] and to the uncertainty of the dielectric constants of diluted solutions and of ionic radii, the author investigates the influence of temperature upon the heat of solution of LiCl at concentrations 0·0133 to 0·0067 N and at temperatures of 18, 12, 0° C. Assuming that the B of the formula $W = -U(1 - \alpha) + B\sqrt{c}$ has the value 320 at 18°, B is found to decrease by 8 units per deg. C. on cooling. Further experiments with NaCl, KCl, $NaNO_3$ and KNO_3 gave close agreement between the calculated and observed values of the heat of dilution, and especially also as to points at which the negative heat becomes positive, when the $B\sqrt{c}$ was replaced by $B\alpha\sqrt{\alpha C}$. H. B.

753. Coagulation of Smokes and the Theory of Smoluchowski. G. Nonhebel, J. Colvin, H. S. Patterson and R. Whytlaw-Gray. *Roy. Soc., Proc.* 116. *pp.* 540–553, *Nov.* 1, 1927.

Smokes are unstable disperse systems which coagulate spontaneously from the moment of formation [see Abstracts 1023, 1024 (1923)]. If it is admitted that every chance collision between the particles in a smoke and in a coagulating hydrosol results in a union, the equations developed by Smoluchowski [*Zeits. physikal. Chem.* 92. *p.* 129, 1918] for the rate of coagulation of colloids should hold also in the case of smokes. The use of the ultramicroscope for the determination of the number of particles in a smoke is criticised, and a special wedge-shaped cell is described which admits of reliable results in such determinations. The results obtained in this way for clouds of ammonium chloride, antipyrine, and cadmium oxide obey the law, $\sigma = \sigma_0 + Kt$, where σ represents the particulate volume, that is the reciprocal of the number of particles per c.c., and t the age of the cloud. This general law is probably valid for all smokes composed of non-volatile particles. The experimental data agree with the requirements of Smoluchowski's theory as closely as those obtained for the coagulation of sols. T. H. P.

754. Viscosities, Electrical Conductivities and Specific Volumes of Acetic Acid-Stannic Chloride Solutions. J. D. Stranathan and J. Strong. *J. Phys. Chem.* 31. *pp.* 1420–1428, *Sept.*, 1927.

The viscosities, electrical conductivities and specific volumes of solutions of stannic chloride in acetic acid are measured for various concentrations of stannic chloride up to that for which the mixture breaks into two layers. The mixing is accompanied by large volume contraction and heat evolution. The volume contraction at certain concentrations amounts to 32·10 % of the volume calculated from a weighted mean of the component specific volumes. The curve relating viscosity to concentration has a very marked maximum. The maximum deviation of the measured viscosity from that calculated from a weighted mean of the component viscosities is remarkably large. The maximum is 282 times as great as that calculated from the additive law; it is 263 times the viscosity of the most viscous component. The maximum of the viscosity curve, and therefore the maximum deviation of viscosity from that calculated from a weighted mean of the component viscosities (since the component viscosities are negligible as compared to the solution viscosity), occurs accurately at a concentration of 0·25. The position of the maximum is probably independent of temperature. In view of the extremely large deviation of viscosity from the additive law, the accuracy with which the peak falls at the concentration corresponding to the compound $SnCl_4 3CH_3COOH$, and the unusually great volume contraction and heat evolution upon mixing, the marked change in properties with concentration is attributed to the formation of a compound $SnCl_4 3CH_3COOH$.

J. N. P.

755. Thermodynamics of Disperse Systems. A. March. *Ann. d. Physik*, 84. 5. *pp*. 605–623, *Nov*. 19, 1927.

In this paper it is shown that the stability of disperse systems with particle radius below 10^{-7} cm.—*i.e.* the true solutions and those which are intermediate between the latter and colloidal systems—depends entirely on the thermal movement of the particles. The degree of dispersion of a system must decrease with increasing concentration and increase with temperature elevation. The stability of a colloidal or coarse disperse system cannot be explained either by thermal movement or by the behaviour of electrically charged particles. From an example of emulsified oil drops it is shown that coagulation should only be prevented by an electrokinetic potential of at least 0·72 volt, whilst actually a potential of 0·03 volt suffices. It is proposed that the stability of a system of particle radius above 10^{-7} cm. arises from the presence of an adsorption layer which surrounds the particles, and by the resistance then offered to separating forces the coalescence of the drops is prevented. H. H. Ho.

756. Application of the Aitken Effect to the Study of Aerosols. H. L. Green. *Phil. Mag*. 4. *pp*. 1046–1069, *Nov*., 1927. *Supplement.*

Describes a form of continuous action Wilson cloud apparatus, which was used in the study of aerosols formed of ultramicroscopic particles of ammonium chloride or of cadmium oxide. Observations were made both visually and photographically of the minute water drops formed by expansion in the Wilson chamber, the photographic plate being moved between the expansions so that a large number of records could be obtained upon it. A series of records were taken at intervals during about an hour and a half, so as to follow the histories of the clouds, and it was found that in the case of ammonium chloride the rate of coagulation of the dry clouds followed the same law as that deduced by Smoluchowski by mathematical treatment of the chance collisions of particles owing to diffusion, though the experimental values of the constant K in the equation were in all cases greater than those deduced from theory. Reasons are given for these differences. H. N. A.

757. Improvements in the Electrical Fusion of Low-Grade Minerals. B. Bogitch. *Comptes Rendus*, 185. *pp*. 863–865, *Oct*. 24, 1927.

Minerals containing 3 to 5 % of copper, nickel or cobalt cannot be concentrated economically by treatment in the usual types of furnace. Iron rich alloys can, however, be obtained by using an electric furnace with vaulted roof, vertical arc, conducting hearth and bricked with chromite. A high-tension arc is used. The carbon of the electrode is not used in the reduction, which is effected by addition as required of the proper agent. The alloys are free from carbon and silicon. L. M. C.

758. Nature of the Protective Film of Iron. T. Fujihara. *Am. Electrochem. Soc., Trans.* 49. *pp.* 327–334; *Disc.*, 334–337, 1926.

When a drop of water is placed on iron with a polished surface, there will appear an uncorroded rim outside of the drop. This is due to a protective film which is produced at that portion. The protective film of iron consists of soluble ferrous hydroxide, which is alkaline. The protective effect of this film would be pronounced if carbon dioxide were excluded from air under which iron is corroding. AUTHOR.

759. Treatment of Iron Alloys in Solutions of Complex Phosphates for Protection against Corrosion. J. Cournot. *Comptes Rendus,* 185. *pp.* 1041–1043, *Nov.* 14, 1927.

Continuing previous work, the author determines the effectiveness of the treatment with complex phosphate solutions as a means of protecting iron and its alloys against corrosion. The results show that the test pieces treated by the phosphates behave as well as those protected by other means, such as plating with nickel, tin, zinc, and in some cases they were markedly superior. The coatings were tested in air, tap-water, sea-water, water charged with carbon dioxide, steam, vinegar, bleach solution, sodium carbonate, bicarbonate and bisulphide. F. J. B.

760. Influence of the Addition of Chromium on the Internal Friction of Ferro-Nickel. P. Chevenard. *Comptes Rendus,* 185. *pp.* 1130–1132, *Nov.* 21, 1927.

In a previous paper [see Abstract 1922 (1927)] the author had shown that the magnetic transformation of the group of invar steels was accompanied by anomalies of expansion and elasticity. In the present communication the author shows that these alloys exhibit anomalies in internal friction. The importance of the results obtained by the addition of chromium for the preparation of steels destined for working at high temperatures is discussed. F. J. B.

761. Hardness and Expansion of Invar. J. F. Saffy. *Comptes Rendus,* 185. *pp.* 1119–1121, *Nov.* 21, 1927.

It is known that the coefficient of expansion of a piece of quenched invar can be deduced from the coefficient of expansion of the material before quenching and the elongations in both states. Since elongation is an awkward quantity to measure, an alternative measure of the work is sought, and it is found that the Brinell hardness can be employed.

A. Wh.

762. Constitution of Aluminium-Magnesium Alloys. T. Halstead and D. P. Smith. *Am. Electrochem. Soc., Trans.* 49. *pp.* 291–311; *Disc.*, 311–312, 1926.

Alloys of Al and Mg containing from 32 to 48 % Mg were prepared in a specially designed apparatus which is described. The thermo-electromotive force and the temperature coefficient of the resistance of the alloys were then determined. The results indicate that there are two regions of solid solution in place of the single β-field found by earlier investigators. The limits of these fields are tentatively given at 36·8 and 38·8 atomic % and at 39·4 and 43·0 atomic % magnesium respectively. These limits relate to the somewhat indefinite temperature at which the structure of the alloys was fixed by annealing them at 308° C. and allowing them to cool down. C. O. B.

763. Effects of Annealing Alloys of Copper-Nickel-Aluminium-Manganese. L. J. Wood. *J. Phys. Chem.* 31. *pp.* 1693–1703, *Nov.*, 1927.

Alloys of Cu-Ni-Al, with or without Mn, were cast in sand or in chilled moulds, and then annealed in an electric furnace. Annealing for seven days at 500° C. having very little effect, the alloys were kept for another seven days at 800° C. The density determinations were made by the method of Egerton and Lee [see Abstract 2051 (1923)], the corrosion tests in 4 N nitric acid at room-temperature or 60° C. Alloys with an Ni-Cu ratio of 2 : 1 approximately and an Al content of 2 to 6 % form essentially an α solid solution when sand cast and quenched from just below red-heat. One % of Mn added to the alloys tended to cause separation of a second constituent, apparently an α-β eutectic; chill-casting tends to minimise this latter eutectic. Annealing generally caused a decrease in the α-β constituent, and also in the density and the corrosion; in some cases all these three properties showed an increase. The maximum combination of valuable properties decreased with increasing proportion of the α-β constituent. The Ni-Cu ration should be low enough to form a homogeneous solution. In none of the fifty non-corrosive ternary alloys of W. Campbell's list [*Proc. Am. Soc. Testing Mat.* 22. *I. p.* 241, 1922] had all the three constituents the same lattice type. Cu, Ni and Al are of the same lattice type, but the manganese crystallises in a different, still uncertain, type, and it may improve the alloys for that reason. H. B.

764. Determination of the Heterogeneous Field in the System Iron-Nickel. K. Honda and S. Miura. *Tohoku Univ., Sci. Reports,* 16. *pp.* 745–753, *Oct.,* 1927. *In English. Report No.* 171 *from the Research Inst. for Iron, Steel and other Metals.*

By means of dilatometric analysis the heterogeneous field in iron-nickel alloys was determined. By the application of the law of depression of the freezing point, the lowering of the A_3 point of iron by the addition of nickel was calculated and found to agree with the observed data. Lastly, the variation of the coefficient of expansion with the concentration in the system iron-nickel was discussed in the light of the structural change of the system. AUTHORS.

765. Chemical Equilibrium in a Mixture of Paraffins. H. A. Wilson. *Roy. Soc., Proc.* 116. *pp.* 501–515, *Nov.* 1, 1927.

By the application of the theory of chemical equilibrium to a mixture of paraffins represented by the formula C_nH_{2n+2}, it is shown that the equilibrium composition of the vapour and liquid phases at any given temperature and pressure may be calculated approximately. Tables are given showing the equilibrium pressures for different temperatures and different values of x, where CH_x indicates the composition of the vapour, and others showing the values of x' ($CH_{x'}$ being the composition of the liquid in equilibrium with the vapour) for different values of x and temperature. With the help of these, a chart is constructed giving the values of x and x' for any temperature and pressure. Strictly, such chart is applicable only for temperatures above about 600° F., but it serves for approximate calculations on vapour at temperatures down to 500° F., provided that the vapour was originally produced above 700° or 800° F. and kept hot long enough for the approximate establishment of equilibrium between the hydrocarbons present. Increase in the pressure is accompanied by increase in the proportion of volatile hydrocarbons in the vapour, whilst increase in the temperature acts in the opposite direction. Reduction of the pressure by one-half has about the same effect as raising the temperature by 100° F. Comparison of the theoretical results with the practical results of large-scale operations on paraffin oils indicates approximate agreement for temperatures above 600° F. In an Appendix various criticisms are answered. T. H. P.

766. Nature of the Activating Radiation in Photochemical Action. W. Taylor and A. Elliot. *Faraday Soc., Trans.* **23.** *pp.* **583–592,** *Sept.*, **1927.**

Actinic extinction curves are obtained by allowing light filtered through various concentrations of chlorine to activate a mixture of hydrogen and chlorine. The activating radiation is shown to be non-homogeneous, and it is shown that the experimental results can be accounted for to a high degree of approximation by assuming (1) that the effective photochemical equivalent of monochromatic light is independent of wave-length between 3500 and 6000, and (2) that for a given frequency the actinic power is directly proportional to the intensity. No evidence is found for assuming that any part of the ordinary optical absorption in this region has special chemical properties, or that two different types of absorption actinic and non-actinic are superposed. J. N. P.

767. Mathematical Treatment of the Kinetics of Simultaneous Reactions. A. Skrabal. *Ann. d. Physik*, **84.** **5.** *pp.* **624–638,** *Nov.* **19, 1927.**

This paper is a reply to Bodenstein's criticism [see Abstract 2421 (1927)] of the author's previous publication [see Abstract 1576 (1927)] on Herzfeld's theory of reaction velocities, in which the validity of the previous conclusions is maintained. The examples investigated are the alkaline hydrolysis of ethyl acetate by an ammonia-ammonium salt combination and the formation of hydrogen bromide from its elements. The Bodenstein equations (*loc. cit.*) are shown to be untenable, and the methods employed only those of approximation. H. H. Ho.

768. Relative Stability of Nitrous Oxide and Ammonia in the Electric Discharge. W. K. Hutchison and C. N. Hinshelwood. *Roy. Soc., Proc.* **117.** *pp.* **131–136,** *Dec.* **1, 1927.**

Experiments are described on the comparison of the rates at which two reactions take place in a discharge tube in order to ascertain if the results are in agreement with the indications of the known thermal reactions. The gases used were nitrous oxide and ammonia, thermal decomposition of the former being known to be more ready than that of the latter. The absolute amount of decomposition tends to be independent of the initial pressure of the gas when the discharge is feeble, but with increasing intensity of discharge the amount of decomposition becomes proportional to the initial pressure, *i.e.* the percentage decomposition is now independent of the initial pressure. This being the condition for satisfactory comparison, all the measurements were made with discharges sufficiently intense to bring the reaction into this " unimolecular " region. Electrodes of platinum, aluminium, and glass were used, and the discharge was passed either through the two gases in parallel or in series or independently through each alone. Under all conditions the ammonia appeared to be about five to seven times as difficult to decompose as the nitrous oxide. It seems fair to conclude that the ionic impacts required to decompose ammonia are considerably more violent than those required to decompose nitrous oxide. T. H. P.

769. The Heat of Formation of Carbon Tetrachloride. M. Bodenstein and P. Gunther. *Am. Electrochem. Soc., Trans.* 49. *pp.* 227–232; *Disc.*, 232–235, 1926.

The heat of formation of carbon tetrachloride was determined and found to be 25,430 ± 350 cal. on the basis of the reaction: $CCl_4 + 2H_2 = C + 4HCl + 62{,}570 \pm 350$ cal. The tendency of the system carbon + chlorine to react is extraordinarily small, and at temperatures from 150 to 500° C. it is apparently impossible to reach a thermodynamical equilibrium from either side of the equation, $C + 2Cl_2 = CCl_4$. AUTHORS.

770. The Parachor and Chemical Constitution. Part VI. Cases of Supposed Ring-Chain Tautomerism. F. B. Garner and S. Sugden. *Chem. Soc., J. pp.* 2877–2883, *Nov.*, 1927.

The evidence of the parachor as to the structure of quinones, acid chlorides, and benzils is presented [see Abstract 2416 (1927)]. The parachors of *p*-benzoquinone and toluquinone indicate that the liquid compounds contain little or none of the peroxide form. For succinyl chloride the parachor shows clearly that the liquid has the symmetrical formula and cannot contain an appreciable amount of the unsymmetrical modification. With phthalyl chloride a difference in the expected direction is found between the two isomerides, but the parachors are not in very good agreement with the predicted value in either case, probably owing to interconversion of the isomerides. From its reactions and colour, benzil is usually assumed to have the ketonic structure. Certain alkyloxy-derivatives are, however, white or very pale yellow, and the view has been expressed that these derivatives should be represented by the peroxide formula, but on fusion these substances give yellow liquids which are supposed to contain an equilibrated mixture of the two forms. For benzil and 2 : 2′-dimethoxybenzil the parachors found are in good agreement with the values calculated for the diketone, and show no indication of the presence of even a small proportion of the isomeride having the peroxide structure. T. H. P.

771. Electromotive Force of the Cell with Transference, and Theory of Interdiffusion of Electrolytes. P. B. Taylor. *J. Phys. Chem.* 31. *pp.* 1478–1500, *Oct.*, 1927.

From the expressions giving the values of the e.m.f. for the two halves of a cell with transference, an integral is derived for the e.m.f. of the general cell with transference, and this integral is then corrected to allow for the transference of the solvent owing to the hydration of the ions and to the solvent of crystallisation. A rigorous derivation is given for the differential equation of the diffusion of electrolytes, and it is shown that this equation depends on the molecular free energies only, and is independent of the ionic free energies. From this it is further shown that the e.m.f. of the cell with transference is independent of the ionic free energies, which may always be chosen in each solution to satisfy any single arbitrary function (not a function of the molecular free energies) without thermodynamic error. A method is given for finding the distribution of concentrations throughout a junction under conditions sufficiently wide to render it generally applicable. Henderson's formula for the e.m.f. at liquid junctions [see Abstracts 1245 (1907); 1737 (1908)] is extended to provide for variable mobilities and activity coefficients; this formula is only an approximation and may be corrected by means of a graphical integral. When applied to the $0 \cdot 1$ N . HCl/KCl cell, the theory developed in this paper gives far more concordant results than those of the simple Henderson formula. The bearing of the results on the determination of *p*H is discussed. T. H. P.

772. Cells with Identical, Unchanging Electrodes. V. Karpen.

Comptes Rendus, 185. *pp*. 766–767, *Oct*. 17, 1927.

Pairs of electrodes of carbon or of metals not attacked by alkalies give an e.m.f. when one is completely and the other only partly immersed in saturated sodium hydroxide solution. The submerged electrode is negative to the other. The e.m.f. decreases with decreasing concentration of the solution, with increasing submersion of the positive electrode and with agitation of the electrodes. The maximum voltages produced, whatever the nature of the electrodes, are of the order of $0 \cdot 5$ volt and depend on the state of the electrode surface. No chemical attack on the electrode can be detected, and no cause for the e.m.f. is suggested.

L. M. C.

773. Cells with Non-Attackable Electrodes. V. Karpen.

Comptes Rendus, 185. *pp*. 942–944, *Nov*. 7, 1927.

When two platinum electrodes are dipped into water covered with a layer of amyl alcohol (or other liquid immiscible with water), both liquids containing sodium hydroxide, the electrode in the alcoholic solution becomes positive to the other and an e.m.f. of $0 \cdot 5$ volt is developed. By immersion of pairs of different but non-attackable electrodes in sodium hydroxide or potassium carbonate solutions an e.m.f. is again slowly developed. The magnitude of this depends on the nature and physical surface of the electrodes. Agitation of the positive electrode lowers and of the negative increases the e.m.f. The potential difference, though slowly, almost entirely disappears if the experiment be carried out *in vacuo* or in an atmosphere of hydrogen, but is restored when an atmosphere of air or of oxygen is replaced. L. M. C.

774. Effect of Series Resistance on the Current from a Photoactive Cell containing a Fluorescent Electrolyte. C. C. and Dorothy W. Murdock.

Faraday Soc., Trans. 23. *pp*. 593–600, *Sept*., 1927.

A property attributed to the photoactive electrolytic cell, composed of a fluorescent electrolyte and platinum electrodes, is the independence of the current on the external resistance of the circuit. As this resistance is increased, a point will, however, be reached at which the heat developed in the resistance will equal the maximum power available, so that the current must decrease with further increase of resistance. Experiments with $0 \cdot 3$ to 6 % alcoholic solutions of rhodamine-β [see Abstract 254 (1927)] as electrolytes, and either bulk platinum or transparent platinum films on glass as electrodes, show that introduction of resistance into the circuit always decreases the value of the steady state current. For the range of resistances used, the reciprocal of the current is a linear function of the resistance according to the equation $1/i = S(r + R)$ . . . (i), where i is

the current, r the resistance of the circuit, S the slope of the experimental curve, and R its negative x-intercept diminished by the resistance of the shunted galvanometer and that of the cell. The total e.m.f. of the circuit is given by $ri = 1/S - Ri \ldots$ (ii). The view is expressed that the photo current in its steady state is simply the residual current resulting from an e.m.f. produced by illumination, and the term Ri is due, in part at least, to the polarisation. That this is actually the case is shown by facilitating depolarisation by stirring the liquid, the x-intercept being then invariably decreased and the slope of the curve increased. The fundamental assumptions of Swensson [Abstract 1113 (1920)] are not inconsistent with the above views, but they take no account of polarisation.
T. H. P.

775. Free Energy of Transition in the System Calcite-Aragonite. J. L. Buchan. *Faraday Soc., Trans.* 23. *pp.* 668–671, *Nov.*, 1927.

Marked discord prevails among the values of the free energy of transition in the system calcite-aragonite given by different investigators. In the method of determination employed by the author use was made of the cell.

Platinum saturated with hydrogen	Saturated solution of calcite in N-KCl containing 25% of alcohol	KCl-solution as before	Saturated solution of aragonite in KCl-solution as before	Platinum saturated with hydrogen

A mixture of hydrogen and carbon dioxide of constant composition and pressure was circulated continuously through the electrode vessels by means of an electromagnetic circulator. In each electrode vessel calcium hydrogen carbonate was formed in an amount depending on the solubility of the particular form of calcium carbonate with which the solution was in contact. The HCO_3' to which this bicarbonate gave rise retarded the dissociation of the carbonic acid also formed, so that a hydrogen-ion concentration cell was obtained. If E is the e.m.f. of the cell, the free energy of transition at the given temperature is given by $F = 2 \,.\, E \,.\, 23{,}070$ calories per gramme-molecule. The object of the potassium chloride is to reduce the internal resistance of the cell and also, as practically the same solution was used throughout, to eliminate the liquid-liquid potentials. The alcohol prevents the solution from freezing, the object being to make some measurements below 0°. The free energy of transition is found to be $-$ 414 calories per gramme-molecule at 25°, this value being in agreement with that given by Kohlrausch and also with that obtained from consideration of the crystal structure. It was found increasingly difficult to obtain reproducible values as the temperature was lowered.
T. H. P.

776. Free Energies of Solid Compounds deduced from their Crystal Structure, with Special Reference to Calcite and Aragonite. J. L. Buchan. *Faraday Soc., Trans.* 23. *pp.* 672–676, *Nov.*, 1927.

The method suggested is based on a consideration of the simplest lattice from which the crystal can be built up by a process of repetition, the ions being taken as point charges. Only an approximation is thus obtained, as strict accuracy would necessitate consideration of every electron in each ion of the lattice and the calculation would be exceedingly laborious, if possible. The force acting between any two ions is taken as that given by J. J. Thomson's formula, $F = \frac{E_1E_2}{Da^2}\left(1 - \frac{K}{a}\right)$, where E_1 and E_2 are the charges on the ions, a the distance between them, D the dielectric constant of the medium, and K a constant depending on the ions under consideration. Integration of the above equation between the limits d and ∞, d being the distance between the two ions considered in the lattice, gives the work required to bring one ion into position when it is acted on by only the other ion, this being $\frac{E_1E_2}{Dd}\left(1 - \frac{K}{2d}\right)$. The free energy of formation of more than one lattice need not be considered, as the energy change when a number of them are brought together to form a crystal of ordinary size would be the free energy of crystallisation, which is very small compared with that of formation. Application of this method to calcite gives, for its free energy of formation from Ca^{++} and CO_3^{--}, the value − 4060 calories per gramme-molecule at 18°; for aragonite the corresponding value is − 3680. The difference, 380 calories, represents the energy of transition in the system calcite-aragonite [see preceding Abstract]. T. H. P.

777. Electrochemical Studies of Titanium. E. D. Botts and F. C. Krauskopf. *J. Phys. Chem.* 31. *pp.* 1404–1419, *Sept.*, 1927.

Metallic titanium is prepared according to the method of Nilson and Pettersson, and the optimum conditions governing its preparation in a crystalline form are determined and various modifications of the method tried. Some very pure crystalline titanium is obtained in pieces varying in size up to 5 grammes. Single potential measurements of titanium are made in M/4 solutions of titanium trichloride and M/4 trivalent sulphate. Considering the normal hydrogen electrode potential as zero and the more active elements as positive, titanium has an average potential in the trichloride solution of 0·23 and 0·18 volt in the sulphate. The single potential of titanium is increased approximately by 0·22 volt when a small amount of hydrofluoric acid is present in the titanous solution. Hydrochloric and sulphuric acids added to their respective salt solutions cause a decided decrease in the single potential of titanium. Alkali salts of common ion with the titanium salt cause a slight increase in the titanium potential. Replacement experiments do not agree with single potential measurements in any solution except the fluorides, in which case agreement obtains with three exceptions, and these replacement reactions show a marked similarity to analogous reactions of elemental silicon. J. N. P.

778. Liquid-Junction Potential Measurement. E. J. Roberts and F. Fenwick. *Am. Chem. Soc., J.* 49. *pp.* 2787–2791, *Nov.*, 1927.

In order to obtain a reproducible liquid-junction potential between an antimony electrode and the reference electrode (Ag, AgCl, 3·5 M. KCl), the authors modify the arrangement of Brönsted, in which the solution flows past the electrode proper slowly through a deep layer of the saturating substance down to the junction. To make the flowing-junction device more flexible and applicable to small volumes of electrolyte, a thin mica plate is interposed vertically between the ends of the two horizontal exit tubes from the electrodes. The electrolyte then streams down the opposite faces of the plate, past a small hole of 1 mm. diameter in the

mica strip of 1·5 by 7 cm. The device gave satisfactory results in determining the potential at the boundary between 0·1 M. HCl and 0·1 M. KCl.
H. B.

779. Diffusion Potential and Dissociation of Hydrochloric Acid.

A. Bühl. *Phys. Zeits.* 28. *pp.* 767–770, *Nov.* 15, 1927. *Paper read before the Deut. Physikertag, Kissingen, Sept.*, 1927.

The author studies the potential difference in the surface double-layer of electrolytes with the aid of cells of the type

$$\mathrm{C}\ \underset{\mathrm{I}}{\Big|}\ \mathrm{S}_1\ \underset{\mathrm{II}}{\Big|}\ \mathrm{air}\ \underset{\mathrm{III}}{\Big|}\ \mathrm{S}_2\ \underset{\mathrm{IV}}{\Big|}\ \mathrm{S}_1\ \underset{\mathrm{V}}{\Big|}\ \mathrm{C},$$

where C stands for calomel electrode and S for solution. Solution 1 drops from a nozzle within a cavity wetted with solution 2. The total potential of the cell is measurable; potential difference I is equal to V, and the diffusion potential IV can be calculated, so that the sum of the two surface potentials II and III can be found by subtraction. The diffusion potential is due to the diffusion from the more concentrated into the diluted solution, the quicker ion taking the lead. The formula of Nernst is inapplicable because he assumes constancy of the mobilities of kation and anion independent of concentration. Kohlrausch recognised a dependence of the mobility upon concentration in 1890. Experimenting with KCl, NaCl, LiCl and HCl, 0·0001 40·2 N, the author finds that HCl has no appreciable surface potential, and that the decrease of conductivity of electrolytes with increasing concentration is due, not to a diminution in the degree of dissociation, but to a diminution in the migration velocity of the ions.
H. B.

780. Passivity of Metals during Anodic Polarisation.

G. Grube. *Z. El. Ch.* 33. *pp.* 389–399, *Sept.*, 1927. *Paper read before the Deut. Bunsen Gesell., Dresden, May*, 1927.

A review is given of the theories which have been put forward to account for polarisation, whereby, with increase of current density, the anodic solution of a metal is replaced by secondary reactions. The oxide film theory is not tenable in some instances, particularly in the case of chromium, though present opinion inclines to the view that passivity is related to the association of oxygen with the surface of the metal, such as by the formation of a solid solution or, as assumed by Tammann, by the union of oxygen with the crystal lattice. In the electron theory of W. J. Müller, passivity is attributed to a change of valency of an anodically dissolving metal brought about by saturation concentration. A theory of Smits assumes the existence of a heterogeneous equilibrium between different atomic complexes in the metal and ions which is disturbed by polarisation. With iron in sodium hydroxide solutions, a progressive increase in the valency of the ions, as far as hexavalent, occurs with increasing anodic potential accompanied by the formation of oxide films. The similar results obtained with cobalt and manganese are described. The behaviour of lead anodes varies considerably with the concentration of the electrolyte. Polarisation with chromium occurs at much lower current densities than with other metals, and in acid the electrolyte gives no indication of oxide film formation.
J. N. P.